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ASTM BULLETIN

Published by
AMERICAN SOCIETY for TESTING MATERIALS

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OCTOBER—1940

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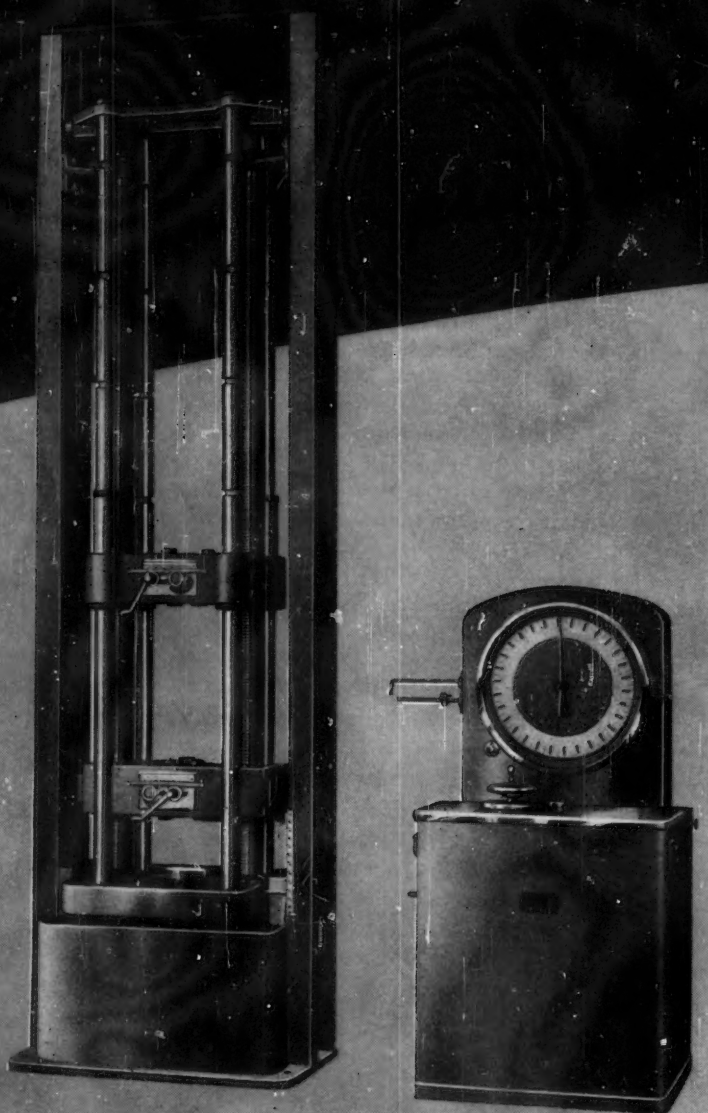

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Number 106 October, 1940

New Tentative Standards and Revisions Approved

Committee on Standards Acts at August Meeting

At its meeting on August 28, 1940, the Society's Committee E-10 on Standards approved for publication a number of new tentative specifications and tests and also took favorable action on numerous revisions in various A.S.T.M. standards and tentative standards. This committee has the authority in the interval between annual meetings to act for the Society in a judicial capacity to determine whether the various standing committees on materials have reached a substantial consensus on their recommendations. A complete list of all actions taken appears below and there is discussion of a number of them, especially new specifications.

Corrosion-Resisting Plate for Pressure Vessels

On the recommendation of Committee A-10 on Iron-Chromium-Nickel and Related Alloys, a new tentative specification will be published covering soft corrosion-resisting chromium-nickel steel sheet, strip, and plate for fusion-welded unfired pressure vessels. There were urgent requests for this specification from the A.S.M.E. Boiler Code Committee and a number of other interests. Four grades are set up labeled *S*, *M*, *C*, and *T* carrying type numbers 304, 316, 347, and 321 classified according to chemical and physical test requirements. Tensile strength minimum is 75,000 psi., yield strength minimum is 30,000 psi., elongation in 2 in. is 30.0 per cent minimum, while the hardness numbers are of varying ranges. Tests required include bend, tensile strength, intergranular corrosion, and hardness. Detailed finish requirements are also included.

Non-Ferrous Metals and Alloys

Consideration by Committee B-2 on Non-Ferrous Metals and Alloys of needed revisions in the specification requirements for solder metal (B 32) resulted in recommendations (approved by Committee E-10) involving the reissuance of the specifications as tentative to carry the designation B 32 – 40 T. The requirements cover two grades of tin-lead and tin-lead-antimony alloys in any form commercially known as soft solder and designated, respectively, *A* and *B*. Recommended practice is given in an appendix to the specifications, together with a table showing liquidus and solidus temperature, also certain of their physical properties including density, and examples of use. This information is given as a guide to the purchaser in selecting the alloy best suited for meeting the required conditions. While specific chemical compositions are not set up, different compositions are suggested such as 60–40, 50–50, 40–60, 25–75, and 38–60–2. Permissible variations in various chemical contents are specified. Requirements for sampling for chemical analysis, preparation of sample of bars and ingots for analysis, and methods of analysis are also prescribed.

A recommendation in the field of cast and wrought copper and copper alloys of predominant importance was the proposed tentative specification for copper-base alloys in ingot form for sand castings to replace the existing standard B 30 – 36 and the tentative specifications B 123 – 39 T covering leaded nickel brass and leaded nickel bronze in ingot form for sand castings. These specifications not only fill a long-felt need in the foundry industry, but are significant from the standpoint of industrial preparedness in which work Committee B-5 on Copper and Copper Alloys has been very active. Twenty-five alloys are covered including such general classifications as tin and leaded tin bronze, high lead tin bronze, leaded red and leaded semi red brass, leaded yellow and leaded high-strength yellow brass, aluminum bronze, leaded nickel brass, etc. Nominal compositions are provided and requirements on chemical properties and tests.

Another Committee B-5 recommendation involved the revision of Tentative Specifications for Seamless Copper Tubes (B 75 – 40 T) which provides requirements for seamless copper tubing suitable for general engineering purposes which may be of three types: phosphorus deoxidized copper, oxygen free copper, and arsenical copper.

Clay and Concrete Pipe, Masonry Units

While the present requirements in the Standard Specifications for Clay Sewer Pipe (C 13 – 40) provide for branding all sizes of pipe larger than 6 in. in diameter, the desirability of having sizes of 4 and 6 in. identified led Committee C-4 on Clay Pipe to recommend a tentative revision providing that each length of pipe shall bear the initials

or name of the person, company, or corporation by whom manufactured, and the location of the mill. This change is set up as tentative only and does not become effective until the committee later recommends its adoption.

The committee on concrete pipe after carefully studying and comparing its specifications covering concrete sewer pipe, C 14 – 35 and C 75 – 35, and concrete culvert pipe, C 76 – 37, recommended the publication of tentative specifications which will eventually replace the standards. Changes in these newer specifications are in general in the interest of clarification. In the new specifications for reinforced culvert pipe (C 76 – 40 T) provisions are made for pipe sizes up to 108 in. in internal diameter—the quality of pipe over 72 in. to be controlled by requirements prescribing concrete quality and reinforcement. These provisions were incorporated because of increasing use of this specification to cover large size pipe.

Changes were incorporated in the Tentative Specifications for Paving Brick (C 7 – 38 T) to bring them in line with Simplified Practice Recommendation R 1-40 of the U. S. Department of Commerce. One change involved the height of lugs which will require that both side and end lugs shall be $^3/_{16}$ in. in height with an allowable variation of $\pm\,^1/_{16}$ in. Dimensional requirements were also added for wire-cut lug brick, the same as for the repressed lug brick, namely, 4 in. deep, $3\,^1/_2$ in. wide, and $8\,^1/_2$ in. long.

In the specifications for structural clay load-bearing wall tile (C 34 – 39) and for structural clay non-load-bearing tile (C 56 – 39) submitted by Committee C-15 on Manufactured Masonry Units there was set up a tentative clause to be adopted later providing a clarification of the requirements for unscored tile. This will indicate to the buyer not to expect too great a degree of perfection when specifying unscored load-bearing wall tile. Requirements are to be the same as for scored material. If closer tolerances on dimensions are desired they must be set up in supplementary specifications.

A tentative revision of the Standard Methods of Sampling and Testing Brick (C 67 – 39) clarified certain procedures including the speed of testing machine and will insure similar procedures of testing by all testing laboratories.

Road and Paving Materials; Roofing Materials

The need expressed by many interests for standardized requirements for cut-back asphalt of the rapid and medium curing types has been met by new tentative specifications. The scopes state that the requirements cover liquid petroleum products produced by fluxing an asphaltic base with suitable distillates or light volatile solvents to be used in the treatment of road surfaces in the manner designated for the respective grades. Six classes or grades of materials are covered in each standard with requirements on various properties such as flash point, viscosity, distillation, and tests on residue from distillation. It is indicated that the various types are used for binders in surface treatments, road-mix construction, cold patch mixtures, and cold-laid plant-mixed construction with open-graded aggregate, and in penetration macadam construction under cold weather conditions.

A number of changes in the Tentative Methods of Sampling Stone, Slag, Gravel, etc., for Use as Highway Materials (D 75 – 39 T) are considered distinct improvements. These methods cover sampling of the materials for the following purposes: preliminary investigation of sources of supply, acceptance or rejection of source of supply, and inspection of shipments of materials. Recommendations are given for stone from ledges or quarries, field stone and boulders, sand and gravel (noncommercial deposits), sand, gravel, stone, and slag (commercial sources), bank run sand and gravel, and miscellaneous materials.

Another change was approved in the Tentative Specifications for Crushed Stone for Waterbound Base and Surface Courses (D 489 – 38 T) providing for use of the Los Angeles machine in determining wear, which is now more commonly used than the Deval machine. The requirements as set up cover the Deval and Los Angeles methods.

Glass and Glass Products; Electrical Insulating Materials

Through the activities of the Society's Committee C-14 on Glass and Glass Products there has been developed after extended work by many laboratories a standardized procedure for measuring the modulus of rupture of glass test pieces. In this new procedure which gives requirements for a bend test to determine the modulus of rupture, this property of a glass product is defined as the maximum tensile stress which the specimen will support without fracture. The modulus is usually taken as the stress at which the specimen breaks in the bending test. Requirements are given for test pieces in the form of rods, flat glass; also methods of computation. In the appendix a method for measuring strain and a sampling procedure are given.

Three of the existing tests developed by Committee C-14 covering hydrostatic pressure test on glass containers (C 147 – 39 T), polariscopic examination of glass containers (C 148 – 39 T), and thermal shock test on glass containers (C 149 – 39 T) were revised to extend sampling procedures to cover not only methods for use in the plant making the containers but for sampling containers unused and used either in transit, warehouse, or bottling plants.

Five existing test methods previously issued through the work of Committee D-9 on Electrical Insulating Materials were revised. The one covering Methods of Test for Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies (D 149 – 39 T) was modified to bring it into agreement with the new procedure for making dielectric strength tests on insulating oils. With the thought that it could be used more readily for reference by NEMA standards, the Methods of Testing Solid Filling and Treating Compounds Used for Electrical Insulation (D 176 – 37 T) have been rearranged. With no satisfactory test apparently likely to be developed covering brittleness or brittleness strength in the Tentative Methods of Sampling and Testing Untreated Paper Used in Electrical Insulation (D 202 – 40 T), the reference to brittleness has been deleted. In view of the development of a standardized test for water absorption of plastics (D 570 – 40 T), Committee D-9 is preparing to bring in line its water absorption test in the Standard Methods of Testing Molded Materials Used for Electrical Insulation (D 48 – 39). Another change involved the size of the test specimen to be used in the water absorption test as part of the Standard Methods of Testing Electrical Porcelain

(D 116 – 39). The requirements indicate that the specimens should weigh from 2 to 50 g. and shall have at least 25 per cent of the surface newly fractured.

Textile Materials

The revisions of the Tentative General Methods of Testing Cotton Fibers (D 414), submitted by Committee D-13 involved a rewriting for clarification, improved procedures for fiber cross-sectioning and for determining neppiness in the length test, and the addition of a chart on selecting test specimens.

Rubber Products

Four of the actions recommended by Committee D-11 on Rubber Products concerned proposed new test methods as follows:

Testing Rubber Compounds for Resistance to Accelerated Light Aging
Calibrating a Light Source Used for Accelerating the Deterioration of Rubber.
Test for State of Cure (T-50 Test).
Test for Tear Resistance of Vulcanized Rubber.

Committee E-10 approved the so-called T-50 Test and the other three methods were accepted for publication as information and comment; they will not be assigned A.S.T.M. designations and are to be published in the *Proceedings* as part of the 1940 report of D-11 and also in the Compilation of A.S.T.M. Standards on Rubber Products which is in preparation.

The T-50 Test according to the scope clause of the new tentative standard, D 599 – 40 T, is designed as a means of determining the extent of cure of a rubber compound by measuring the temperature at which it recovers its elasticity, when it is stretched at room temperature, frozen at a sufficiently low temperature to cause it to lose its elastic properties, and then gradually warmed. When carried out under properly controlled conditions, the T-50 value shows a good correlation with combined sulfur in a stock of given composition, and a qualitative correlation with combined sulfur in stocks of varying compositions. It is mainly useful in controlling and checking uniformity of cure in production and as a tool in experimental work where knowledge of the state of cure is important. It is not suitable for use in purchase specifications.

The method of testing rubber compounds for resistance to accelerated light aging is intended for use as a static accelerated test applicable for estimating the comparative resistance of soft vulcanized rubber compounds to deterioration when exposed to light having a frequency range approximating that of sunlight but a greater intensity in the ultraviolet range than sunlight. The companion method for calibrating a light source is intended primarily for use in measuring the intensity of radiation from the light source. It may also be used for measuring and integrating the intensity or total exposure from other light sources which are intermittent or variable in intensity such as sunlight and for comparing light sources.

The proposed test for tear resistance describes a procedure widely used for determining tear resistance of the usual grades of soft vulcanized rubber such as tire tread, carcass and inner tube compounds or those used in most mechanical rubber goods. It does not apply to the testing of material ordinarily classed as hard rubber. The results obtained can only be regarded as a measure of the resistance under the conditions of that particular test and not necessarily as having any relation to service value.

(Continued on next page)

NEW TENTATIVE STANDARDS

Tentative Specifications for:
- Corrosion-Resisting Chromium-Nickel Steel Sheet, Strip, and Plate for Fusion-Welded Unfired Pressure Vessels (A 240 – 40 T) *Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel, and Related Alloys*
- Soft Solder Metal (B 32 – 40 T) *Committee B-2 on Non-Ferrous Metals and Alloys*
- Copper-Base Alloys in Ingot Form for Sand Castings (B 30 – 40 T) *Committee B-5 on Copper and Copper Alloys, Cast and Wrought*
- Concrete Sewer Pipe (C 14 – 40 T)[1] *Committee C-13 on Concrete Pipe*
- Reinforced Concrete Sewer Pipe (C 75 – 40 T)[1] *Committee C-13*
- Reinforced Concrete Culvert Pipe (C 76 – 40 T)[1] *Committee C-13*
- Cut-Back Asphalt (Rapid Curing Type) (D 597 – 40 T) *Committee D-4 on Road and Paving Materials*
- Cut-Back Asphalt (Medium Curing Type) (D 598 – 40 T) *Committee D-4*

Tentative Methods of:
- Flexure Testing of Glass (C 158 – 40 T) *Committee C-14 on Glass and Glass Products*
- Test for Physical State of Cure of Vulcanized Rubber (T-50 Test) (D 599 – 40 T) *Committee D-11 on Rubber Products*
- Chemical Analysis of Rubber Products (D 297 – 40 T) *Committee D-11*

REVISIONS IN EXISTING TENTATIVE STANDARDS

(Incorporated Immediately)

Tentative Specifications for:
- Seamless Copper Tubes (B 75 – 40 T)
- Paving Brick (C 7 – 40 T)
- Crushed Stone for Water-Bound Base and Surface Courses (D 489 – 40 T)
- Insulated Wire and Cable: Heat-Resisting Rubber Compound (D 469 – 40 T)

Tentative Methods of:
- Hydrostatic Pressure Test on Glass Containers (C 147 – 40 T)
- Polariscopic Examination of Glass Containers (C 148 – 40 T)
- Thermal Shock Test on Glass Containers (C 149 – 40 T)
- Sampling Stone, Slag, Gravel, Sand, and Stone Block for Use as Highway Materials (D 75 – 40 T)
- Test for Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies (D 149 – 40 T)
- Testing Solid Filling and Treating Compounds Used for Electrical Insulation (D 176 – 40 T)
- Sampling and Testing Untreated Paper Used in Electrical Insulation (D 202 – 40 T)
- Test for Compression Set of Vulcanized Rubber (D 395 – 40 T)
- Tension Testing of Vulcanized Rubber (D 412 – 40 T)
- Testing Rubber Insulated Wire and Cable (D 470 – 40 T)
- Test for Changes in Properties of Rubber and Rubber-Like Materials in Liquids (D 471 – 40 T)
- Testing Cotton Fibers (D 414 – 40 T)
- Test for Index of Refraction of Transparent Organic Plastics (D 542 – 40 T)

[1] This specification is a tentative revision of the existing standard, but will not supersede the standard until adopted in some ensuing year.

TENTATIVE REVISIONS OF STANDARDS

(Not incorporated, but published for comment)

Standard Specifications for:
- Clay Sewer Pipe (C 13 – 40)
- Structural Clay Load-Bearing Wall Tile (C 34 – 39)
- Structural Clay Non-Load-Bearing Tile (C 56 – 39)

Standard Methods of:
- Sampling and Testing Brick (Modulus of Rupture, Compressive Strength, Absorption) (C 67 – 39)
- Testing Molded Materials Used for Electrical Insulation (D 48 – 49)
- Testing Electrical Porcelain (D 116 – 39)
- Sample Preparation for Physical Testing of Rubber Products (D 15 – 39)

WITHDRAWALS

Standard Specifications for:
- Solder Metal (B 32 – 21), replaced by Tentative Specifications (B 32 – 40 T)
- Copper-Base Alloys in Ingot Form for Sand Castings (B 30 – 36), replaced by Tentative Specifications (B 30 – 40 T)

Standard Methods of:
- Analysis of Roofing Felt for Fiber Composition (D 272 – 34)
- Chemical Analysis of Rubber Products (D 297 – 39), replaced by Tentative Methods (D 297 – 40 T)

The method is useful therefore only for laboratory comparisons and is not applicable for service evaluations except when supplemented by additional tests and is not for use in purchase specifications.

Changes were approved and are being incorporated in four methods of test—one covering compression set of vulcanized rubber (D 395), which is considered an improvement in the constant deflection type test. It involves reporting compression set in terms of original deflection and provides data of most value. While the change in the Methods of Tension Testing of Vulcanized Rubber (D 412) is not extensive, it is extremely important since it involves the question of interpretation and analysis of data. After detailed discussion, the subcommittee in charge decided that in case the ultimate tensile strengths fail to check within 10 per cent of the highest value obtained, additional specimens shall be tested until two or more such check results are obtained. The old figure was 5 per cent.

Revisions in the Methods of Testing Rubber Insulated Wire and Cable (D 470) involve the ozone resistance test and give better temperature regulation during test and provide improvement in the determination of ozone concentration.

Instead of dieing out the dumbbell test pieces after immersion in the Test for Changes in Properties of Rubber and Rubber-Like Materials in Liquids (D 471), this is now to be done before immersion. Revisions which have been approved also reduce the time interval after removal from the liquid for determining tensile strength and elongation from 24 hours to 4 hours.

Because the 120-hr. air oven test at 121 C. is considered too long and too mild for the present type of compounds designed to resist heat and aging, it has been deleted from the Specifications for Insulated Wire and Cable: Heat-Resisting Rubber Compound (D 469), which leaves the air pressure heat test and the oxygen bomb test requirements, both of which are more severe than the air oven.

One of the Committee D-11 methods covers Sample Preparation for Physical Testing of Rubber Products (D 15), and because very important advances have been made in equipment and technique in buffing, modifications have been set up in this requirement which in general are in agreement with the new procedure established at the National Bureau of Standards.

The final action recommended by the committee and approved by the Society is the result of a great deal of work carried out by the D-11 subcommittee in charge of Methods of Chemical Analysis of Rubber Products (D 297). Based on extensive inter-laboratory cooperative work and contacts with other groups new tentative methods of chemical analysis have been set up, carrying the designation D 297 – 40 T, replacing the existing standard D 297. The methods are classified into four separate procedures as follows: complete procedure, rubber solvent method, short procedure, and copper and manganese determination in crude rubber.

New York Meeting on October 17 to Feature Glass

On the evening of Thursday, October 17, there will be a meeting of the guests and members in the New York District, to be held at the Hotel Pennsylvania. There will be an informal dinner at 6:30 o'clock after which two talks will be given. Cloyd M. Chapman, Past-president and Honorary Member, will preside, introducing the speakers and leading the discussion.

Mr. Games Slayter, Vice-President, Owens-Corning Fiberglas Corp., will give a talk on "Fiberglas." This is the glass thread material used in textiles, filter-cloth, heat insulation, electrical insulation, etc. Another talk will be given by Dr. George W. Morey, of the Geophysical Laboratory, Carnegie Institution of Washington, and chairman of A.S.T.M. Committee C-14 on Glass and Glass Products, whose subject will be "Glass Other than Fiberglas," discussing the manifold uses of glass.

The meeting will coincide with the meetings of Committee D-13 on Textile Materials which convene at the same hotel, October 16 to 18.

Owing to the important and many diverse uses of glass, it is felt the talks will be of extreme interest. Lantern slides will be used to illustrate the lectures and there will be a large exhibit of modern glass products. A cordial invitation to attend the meeting is extended to all who are interested.

Complete review of current A.S.T.M. research projects appears on pp. 52 to 63, incl.

"Specifications" Theme of Philadelphia Meeting

The Philadelphia District Committee of the American Society for Testing Materials has planned a novel and timely meeting for Friday, November 15.

It is increasingly recognized that "Specifications" will be a most important factor in our program of industrial and military preparedness. Whether they like it or not, most engineers and business men will spend much time reading, interpreting, or writing specifications. Upon their clarity, practicability, and sufficiency, depend the suitability of all of the manifold articles that will be purchased.

Specification writing has had no Dale Carnegie as public speaking has had. Specification writing has perhaps suffered by the lack of a spokesman.

In order to air the variety of thoughts and opinions, an open meeting will be held on the above date at the Engineers' Club of Philadelphia. Anyone who is interested may attend. A dinner will be served at 6:30 p.m. ($1.25) and the meeting will start promptly thereafter, at eight o'clock.

There will be no prepared speeches for this meeting. Everything said will be strictly "off the record," since no minutes will be kept, and what is said will not be published. Many experts in their line will be present, but the discussion will be open to all.

Further information on this most interesting meeting may be obtained from the Philadelphia District Committee, Mr. F. G. Tatnall, chairman, Baldwin-Southwark Div., Paschall Post Office, Philadelphia, or from the Society's Headquarters at 260 S. Broad St., Philadelphia.

Rubber in Compression[a]

By E. G. Kimmich[1]

THE EFFECTS of shape and surface conditions of rubber used in compression have remained somewhat of a mystery because of the apparently conflicting results often obtained. It is to be hoped that the work herein described will (1) explain some of the difficulties encountered, (2) establish a simple and reasonably accurate procedure for predetermining the compression stress-strain performance of many of the commonly used shapes, (3) encourage an extension of this work to include more complicated shapes, and to provide further refinement of the results.

Compression uses of rubber doubtless far exceed in number the shear and tension uses for industrial applications, and warrant much work in determining the relationships involved, at least to the extent of establishing empirical rules of sufficient scope and accuracy for practical use.

The erratic nature of compression test results has made it difficult to correlate the data reported in the technical articles on this subject. It is herein indicated that much of this difficulty may be explained by the condition of the surfaces, the manner of applying the load, discrepancies in hardness measurements, variations in the actual stiffness of the rubber used, and the fact that the stress-strain graph is not a straight line.

---

[a] Presented at the Meeting of A.S.T.M. Committee D-11 on Rubber Products, Atlantic City, N. J., June 28, 1940.

[1] Mechanical Goods Dept., The Goodyear Tire and Rubber Co., Inc., Akron, Ohio.

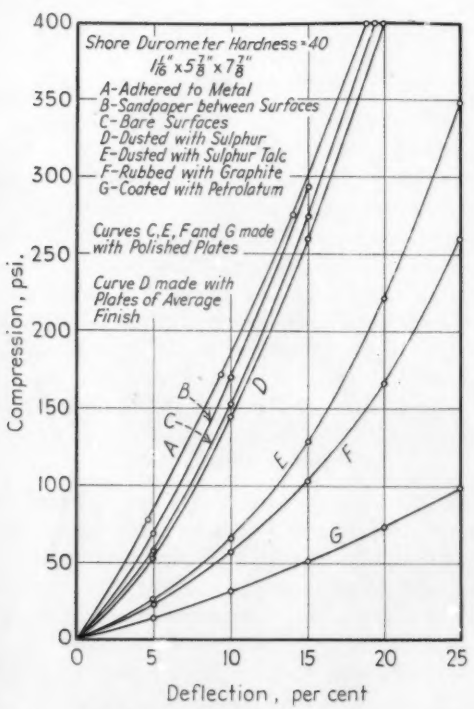


Fig. 1.—Effect of Surface Conditions on Compression Deflection of Rubber.

Surface Conditions

When rubber is compressed between plates, there is a tendency of the rubber to move outwardly from the center of the contact area. This movement may be resisted completely at the pressure plate surfaces by bonding the rubber to the metal; it may be resisted almost completely with roughened surfaces; or it may be resisted practically not at all if a very little lubricant, such as petrolatum, is applied to the surfaces. If the lateral movement at the pressure plates is restricted more in one case than in another, a difference in stiffness may be indicated where no actual difference exists in the rubber itself.

Figure 1 illustrates the effect of surface conditions. These tests were made on a single piece of rubber under various conditions, (*A*) fully bonded to metal by brass plate adhesion, (*B*) cut from the metal and held with sandpaper, (*C*) clean, tacky rubber surface against polished steel plates, (*D*) lightly dusted with sulfur to simulate a bloomed condition and tested with average finished plates, (*E*) dusted with talc, (*F*) rubbed with graphite, (*G*) lubricated with petrolatum. The last three were made with polished steel plates. With so large a difference in stress-strain test results definitely attributable to surface lubrication or the lack of it, it is reasonable to conclude that accidental partial lubrication such as dust, bloom, wax, or grease and the degree of roughness of the pressure plates will explain some of the erratic results where sufficient care has not been taken to eliminate these variables.

Load Application

Speed of load application seems to make little difference in the ordinary testing machine speed ranges, usually 1/8 to 2 in. per min. Rapidly repetitional loading or impact loading usually causes an increase in apparent stiffness which varies with the speed of impact or frequency of vibration. This paper is confined to so-called "static" or very slow speed test machine results. Even in static tests, it is important not to draw precise conclusions from the first application of the load. About ten applications are needed to reach a reasonably constant value, but the purpose is well served ordinarily when three load applications are used. The work herein reported, except where otherwise noted, shows the results of the third application of load.

Stiffness and Hardness Measurements

Considerable confusion has resulted from the terminology. Hardness is properly defined either as the relative ability of one material to scratch the surface of another, or as the relative resistance to surface indentation. Neither of these concepts meets the need of the engineer who wishes to design a compression piece of rubber. The term "modulus" has been used to express the relative resistance of rubber pieces in resisting deformation, but this term is not completely satisfactory because of the curvature of the stress-strain graph. "Rigidity" would be acceptable if it were not so closely identified with shear stresses as in the term "modulus of rigidity."

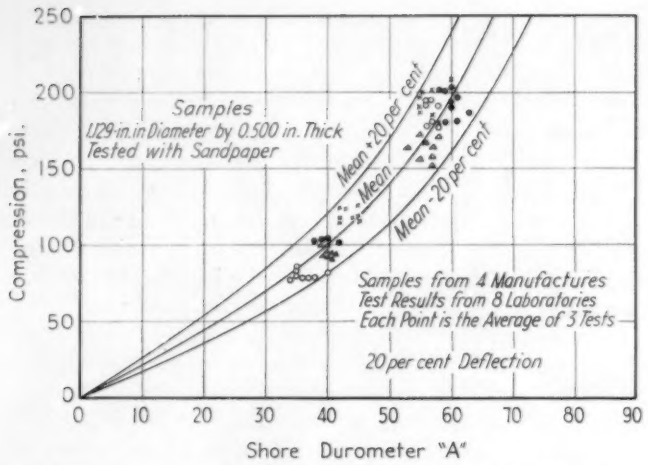

Samples
1.129 in. in Diameter by 0.500 in. Thick
Tested with Sandpaper
Mean + 20 per cent
Mean
Mean - 20 per cent
Samples from 4 Manufactures
Test Results from 8 Laboratories
Each Point is the Average of 3 Tests
20 per cent Deflection
Compression, psi.
Shore Durometer "A"

Fig. 2.—Comparison of Durometer and Compression Deflection Measurements.

Tests Conducted by Technical Committee A of Committee D-11.

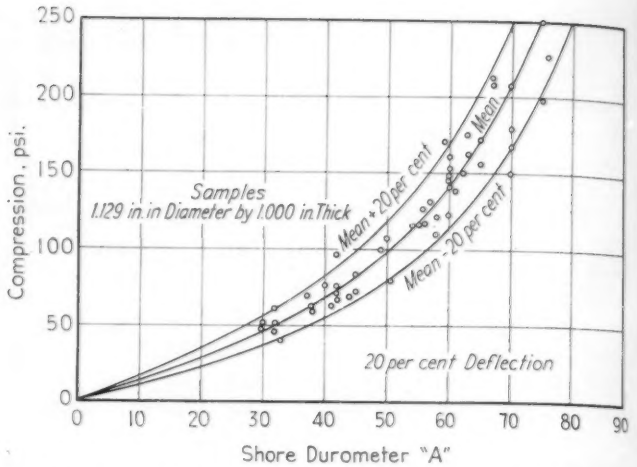


Fig. 3.—Comparison of Durometer and Compression Deflection Measurements.

Tests made in Goodyear Laboratory and cover wider range of stiffness than in Fig. 2.

Brown[2] has recently advocated the term "stiffness" which appears to be best qualified to indicate the resistance to deformation of a piece of rubber under compression loads. Brown has also discussed the fact that "compression" itself is hardly a correct term but it is commonly used and understood in the sense employed herein.

The only measurement of the resistance of rubber to deformation that, at present, even approaches a universal language, is the Shore durometer scale of hardness and much of the reported data is based on such measurements. However, both the instruments and the manner of their use have been very inaccurate.

It is very common occurrence to find a lack of agreement by as much as 5 points on the same piece of rubber by various persons using different durometers. It is unfortunate that there has not been developed a standard method of calibration of these instruments and a standard method of use.[3] A point apparently ignored in discussion of Shore hardness measurements is that a 5 point variation is equivalent to 15 or 20 per cent in actual stiffness as measured in a compression deflection test. When it is considered that larger disagreements than 5 points are not rare (and at times are as high as 10 or 12 points) the effect on comparisons of compression tests and the difficulty of meeting the users' requirements are easily seen.

In no way does this statement discredit the value of the durometer to the rubber industry. A standardized calibration and improved method of use would go far toward eliminating these difficulties. Larrick[4] presented a very useful paper showing that it is entirely practicable to improve the accuracy of durometer measurements.

On the other hand, it has not been established that any indentation test could give a completely reliable report of the compressive characteristics of a piece of rubber. Therefore, consideration is now being given to the adoption of standard methods of compression deflection tests designed to supplement all ordinary hardness measurements.[5] Obviously, such a test will not be as conveniently used as a pocket hardness instrument, and a small portable device will doubtless continue to be used for rough checking.

Wherever in this paper durometer readings are cited, the present general lack of precision of such measurements should be remembered. Figures 2 and 3 show that the degree of correlation between durometer hardness and compression deflection is not better than 20 per cent plus or minus from the mean. The tests in Fig. 2 were conducted by Technical Committee A on Automotive Rubber of the Society's Committee D-11 on Rubber Products in 8 laboratories and on 8 compounds, each point being the average of 3 tests. Figure 3 shows similar data taken in the Goodyear laboratories on our own compounds with samples twice as thick.

Variations Due to Cure

The well-known heat insulating qualities of rubber occasion much difficulty in obtaining uniform vulcanization throughout thick pieces. Usually 2-in. thickness is considered the commercial maximum, although thicker pieces are successfully cured by long, carefully controlled "step" cures. The actual stiffness varies considerably with the cure and cures are selected to obtain optimum values of the characteristics most important in use.

Thus, where low compression set is important, longer cures are ordinarily used than where maximum tensile strength and stretch are the most important properties.

Stress-Strain Curves

The fact that stress is not proportional to strain in rubber causes much difficulty of a type that is absent completely with materials like steel. It is common practice to assume that the graph is a straight line up to 20 to 25 per cent and in many cases this introduces no large error. In thin wide pieces the limits within which this approximation is permissible may be much below 20 per cent de-

[2] Roy Brown, "Engineering Properties of Rubber in Compression," a paper presented June, 1940 at a meeting of the Society of Automotive Engineers, White Sulphur Springs, Va.

[3] Subcommittee XVII on Rubber Products for Absorbing Vibration, of Committee D-11 on Rubber Products, is at present considering standardization of calibration and use of durometers.

[4] Lewis Larrick, "The Standardization of Durometers," *Proceedings*, Am. Soc. Testing Mats., Vol. 40 (1940).

[5] Tentative Methods of Test for Compression-Deflection Characteristics of Vulcanized Rubber (D 571 – 40 T), 1940 Supplement, Part III, to Book of A.S.T.M. Standards.

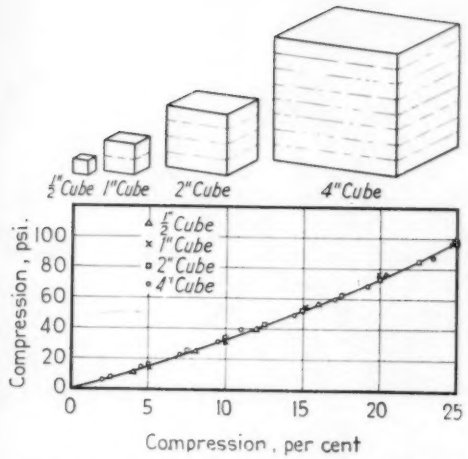


Fig. 4.—Compression Tests of Several Sizes of Cubes Prepared from One Slab of Rubber ½ In. Thick, Having a Shore Durometer Hardness of 40.

Note that these tests prove that similar pieces of one compound, uniformly cured require the same unit load to give equal percentage deflection.

flection. Figures 1, 4, and 5 show the curvature of typical compression stress-strain curves.

Compression of Similar Shaped Pieces

It should be considered axiomatic that similarly shaped pieces will give the same percentage deflection with equal unit compressive loads. When this rule does not hold in actual test, it is likely that one of the difficulties explained above has caused the discrepancy. To check this, with such causes of error eliminated so far as practicable, ½-in. thick slabs of rubber of 40 Shore durometer hardness were cut into pieces that permitted the assembly of ½, 1, 2, and 4-in. cubes. Figure 4 shows that a range of 1 to 8 in linear dimensions of the cubes, or a range of 1 to 512 in volume did not cause any deviation from this rule. It was further confirmed by testing a series of disks assembled from a ¼-in. thick slab of compound of 65 Shore durometer hardness, with results as shown in Fig. 5. In these tests, the joints do not gap open, are obviously under compression and, therefore, do not affect the results. This rule of proportionality pertaining to similar shaped pieces permits accurate conclusions from scale models if cure variations are allowed for.

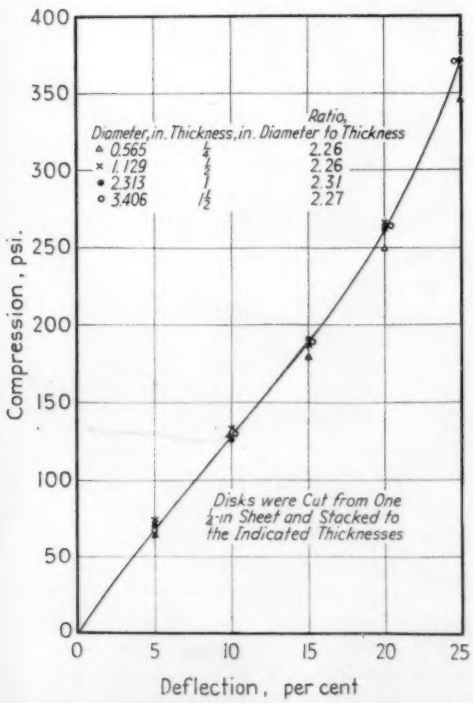


Fig. 5.—Compression-Deflection Tests of Similar Disks or Cylinders. Shore Durometer Hardness = 65.

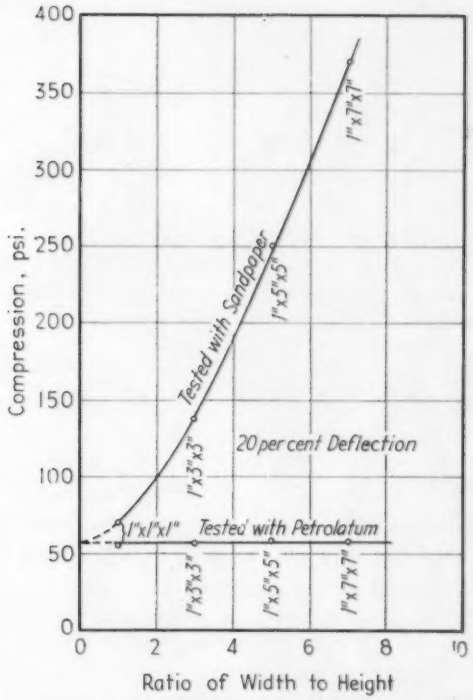


Fig. 6.—Compression-Deflection Tests of Square Slabs Having a Shore Durometer Hardness of 40, Referred to Ratio of Width to Height. Slabs Are Included in Fig. 9.

Shape Factors

Inasmuch as published empirical rules for shape factor correction did not seem to be adequate, we approached the

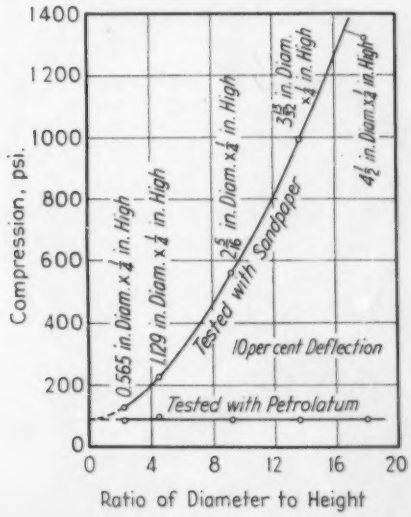

0.565 in. Diam. x ¼ in. High
1.129 in. Diam. x ¼ in. High
2.26 in. Diam. x ¼ in. High
3.39 in. Diam. x ¼ in. High
4.52 in. Diam. x ¼ in. High
Tested with Sandpaper
10 per cent Deflection
Tested with Petrolatum
Compression, psi.
Ratio of Diameter to Height

Fig. 7.—Compression-Deflection Tests of Disks Having a Shore Durometer Hardness of 65, Referred to Ratio of Diameter to Height.

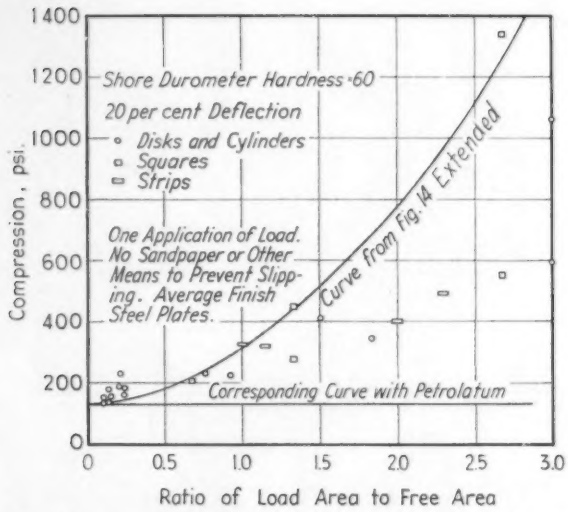

Shore Durometer Hardness 60
20 per cent Deflection
Disks and Cylinders
Squares
Strips
One Application of Load. No Sandpaper or Other Means to Prevent Slipping. Average Finish Steel Plates.
Curve from Fig. 14 Extended
Corresponding Curve with Petrolatum
Compression, psi.
Ratio of Load Area to Free Area

Fig. 8.—Compression-Deflection Tests Made in 1934 to 1935.

problem with an attempt to group various shapes into classifications each one of which would have its own shape factor. Thus, we intended to allow for the shape and intended to use the rule of proportionality for the size of the piece in question. Early trials showed the same type of discrepancies within any one such group, but with improvement in testing technique we began to obtain satisfactory results, or at least reasonable explanations for the deviations.

Square slabs, cubes, and square columns were considered as one classification of shapes, and the ratio of width to height was used as a shape factor for this group. Figure 6 shows one such experimental curve. Disks or cylinders were similarly studied as another shape classification represented in Fig. 7 where the relative resistance to compressions is plotted as a function of the ratio of the diameter to the height.

Figures 6 and 7 also show results of tests on the same pieces using petrolatum and polished steel plates. From these tests, we may conclude: (1) that shape within the limits studied makes no difference in unit compressive load for a given percentage deflection when the surfaces

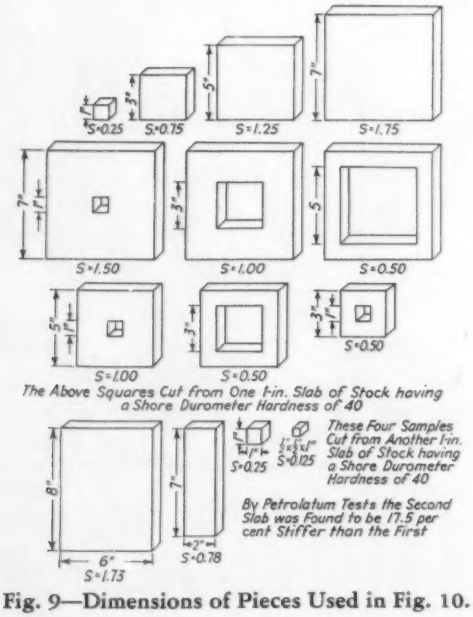


Fig. 9—Dimensions of Pieces Used in Fig. 10.

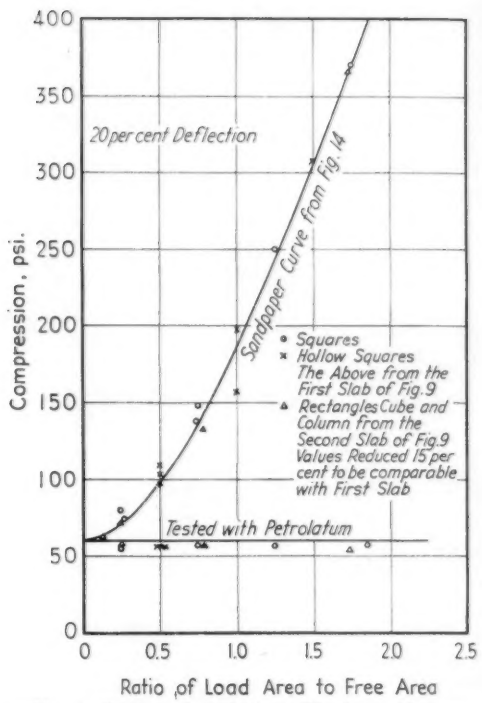

20 per cent Deflection
Sandpaper Curve from Fig. 14
Squares
Hollow Squares
The Above from the First Slab of Fig. 9
Rectangles Cube and Column from the Second Slab of Fig. 9 Values Reduced 15 per cent to be comparable with First Slab
Tested with Petrolatum
Compression, psi.
Ratio of Load Area to Free Area

Fig. 10.—Shape Factor Applied to Various Shapes of Compounds Having a Shore Durometer Hardness of 40. Data of Fig. 6 Are Included.

are thoroughly lubricated, (2) that complete restriction to lateral motion at the loading plates greatly stiffens the piece when the ratio of width to height is large, (3) that as the relative thickness or height increases, the surface condition becomes less important and that with low shape factors the effect almost disappears, (4) that the restricted and lubricated curves extended toward the load axis must become tangent to each other and must intercept the load axis at this tangent point (obviously a shape factor of zero cannot be had but the zero point is

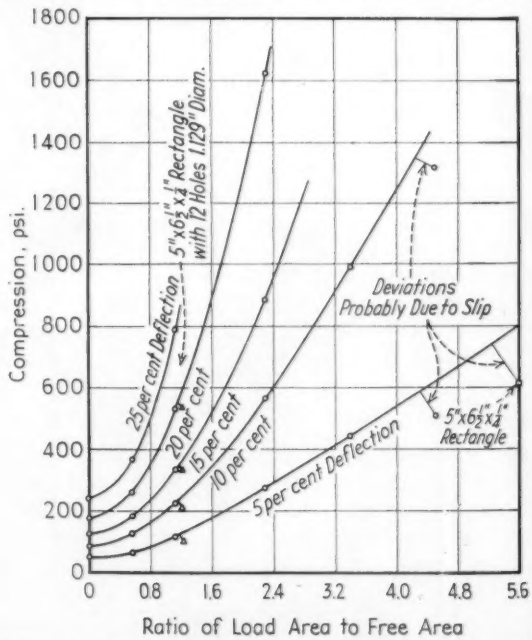

5" x 6½" x 1" Rectangle with 12 Holes 1.129" Diam.
25 per cent Deflection
20 per cent
15 per cent
10 per cent
5 per cent Deflection
Deviations Probably Due to Slip
5" x 6½" x 1" Rectangle
Compression, psi.
Ratio of Load Area to Free Area

Fig. 11.—Shape Factor Applied to Various Pieces Cut from One Slab Having a Shore Durometer Hardness of 65. Data of Fig. 5 and Fig. 7 Are Included. Samples Not Otherwise Indicated Are Cylinders.

useful in defining the curves and assisting in fully comprehending the effect of shape), and (5) that any partial lubrication would result in a curve lying between these two lines as limits.

This approach promised success but indicated the need of much tedious testing to obtain separate empirical rules for all common shapes. We were then led to reconsider the rule set forth by Keys[6] in 1937 in which he used the ratio of one loaded area to the free area at the sides as a shape factor. In his paper, he states that he applied it mainly to square slabs and cubes but found some measure of success with other shapes. Later Hirshfeld and Piron[7] wrote that Keys' shape factor method has serious limitations. Our subsequent work, however, indicates that this type of shape factor is the most satisfactory yet proposed and that the limitations cited by Hirshfeld and Piron are not necessarily as serious an objection as indicated by them.

Applying this rule to cubes, square slabs, and columns with width a and height t, we have for S as a shape factor:

$$S = \frac{a^2}{4at} = \frac{a}{4t}$$

Similarly for disks or cylinders of diameter d and height t, we have

$$S = \frac{\pi d^2}{4\pi dt} = \frac{d}{4t}$$

Note that these values of S are merely one-fourth the factors previously used in our work. Therefore, the shape factors S are identical in *effect* with those used by us in Figs. 6 and 7. Now if the ratio of load area to free area can be proved to meet the requirements of any shape having parallel loading faces and sides normal to the faces, it will be very useful indeed.

When we tried to apply this rule to a number of unpublished tests made by our company in 1934 and 1935, it was thought at that time not to apply very well. Figure 8 shows some of this work in relation to the ratio of load to free areas. Such erratic results have been typical of most of the compression deflection tests reported on in the literature. Reasons for some of the deviations are now understood. At the time of the earlier work, no unusual precautions were known to be needed as to surface conditions. The readings were usually taken on the first application of the load. Obviously, the actual inherent stiffness of the rubber itself was not constant for all the samples in Fig. 8. Note, however, that the upper and lower curves (extended from Fig. 14) reasonably well denote the limits.

The data in Figs. 6 and 7 have been repeated in Figs. 10 and 11 with some additional tests and plotted in relation to the ratio of load area to free area. Data on hollow squares, rectangles, and a perforated slab are included.

It was thought advisable to check the results on squares and strips as reported by Hirshfeld and Piron. They showed that pieces in the proportions of 1 by 1 by 0.125 were approximately 50 per cent stiffer than pieces of the same compound in proportions 1 by 10 by 0.227, both pieces having a shape factor of 2.00. They used compounds of 30 and 60 Shore durometer hardness. Our first trials checked this degree of difference closely, but we subsequently measured the inherent stiffness of the rubber by making petrolatum tests which virtually eliminate the effect of shape factors of this magnitude. This revealed considerably greater *inherent* stiffness in the small thin samples. When this was allowed for on the later tests, the small samples showed 25 and 29 per cent stiffer, respectively, for compounds of 35 and 60 Shore durometer hardness stocks than the strips. We further checked this with new samples made from a single 1/8-in. sheet of each of the two stocks, laminating the cured stock to get 1/4-in. samples and we cut them 1.11 in. wide to restore the 2.00 factor. Figure 12 shows the results. It seems definite that the thin pieces are 25 to 30 per cent stiffer when all experimental error is eliminated. In view of the many other variables still inadequately controlled, and lacking a better shape factor, a discrepancy of this size in a relatively few cases should not deter us from the use of this factor.

Other Shape Factor Formulas

Brown in the paper previously referred to[2] proposed the use of the ratio of the sum of the two loaded faces to the entire surface of the piece as a shape factor. Brown's method is rather closely related to Keys' method, so closely that if the ratio of load to side areas is considered to have limitations, the Brown method has precisely the same limitations. Where x is one loaded area and y the total side area and S the shape factor for the ratio of load area to free area:

$$\frac{x}{y} = S$$

Brown's formula similarly treated gives:

$$\text{shape factor} = \frac{2x}{2x + y} = \frac{S}{S + 0.5}$$

Therefore, when two pieces have an identical shape factor

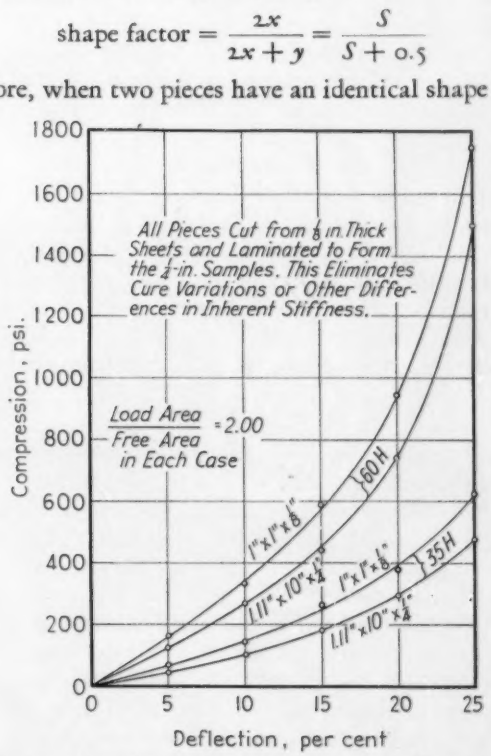


Fig. 12.—Showing the Extent of Deviation in the Case of Relatively Long, Thin Strips.

[6] Walter C. Keys, "Rubber Springs," *Mechanical Engineering*, Vol. 59, May, 1937, pp. 345–349.

[7] C. F. Hirshfeld and E. H. Piron, "Rubber Cushioning Devices," Am. Soc. Mechanical Engrs., *Transactions*, Vol. 59, pp. 471–491 (1937).

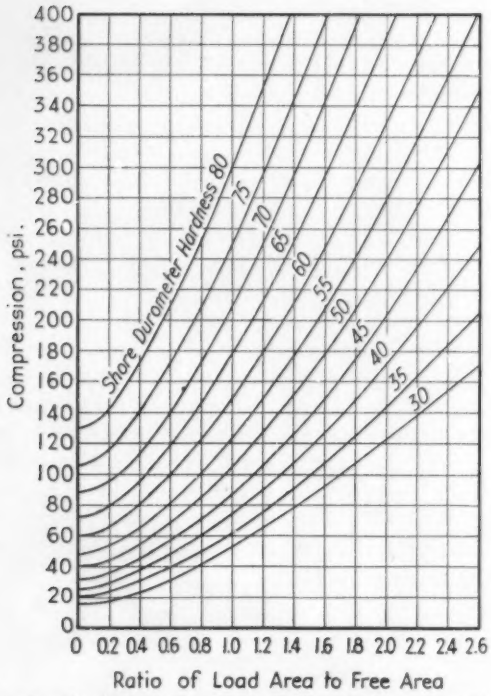


Fig. 13.—Loads for 10 Per Cent Deflection for Various Hardnesses and Shape Factors. Based on Elimination of Slipping at the Load Faces. Temperature 70 to 90 F.

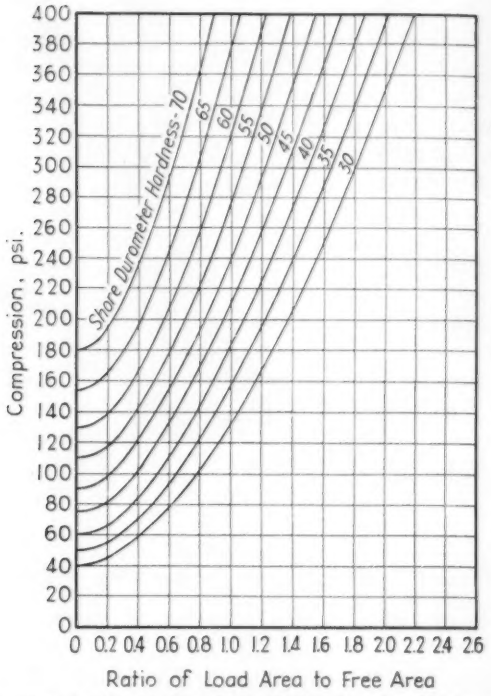


Fig. 14.—Loads for 20 Per Cent Deflection for Various Hardnesses and Shape Factors. Based on Elimination of Slipping at the Load Faces. Temperature 70 to 90 F.

by the one method, they also have identical shape factors by the other, and to whatever extent the Hirshfeld and Piron comment applies in the one case, it will be equally applicable in the other. For instance, any shape having a ratio of one load area to the free area equal to 2.00 will have a ratio of both loaded areas to the total area equal to 0.80. This is limited to pieces having parallel, flat loading faces, but neither rule is applicable to shapes outside of this restriction.

The loaded area over free area shape factor is somewhat easier to use and provides more accuracy for high shape factors where Brown's value approaches unity as a maximum.

Shape Factor Charts

Figures 13 and 14 show in convenient form the data on compression deflection for various hardnesses and various shapes for 10 and 20 per cent deflection, using the ratio of load area to free area as the shape factor. These figures are based on elimination of slipping at the loading faces. They will, therefore, apply to bonded pieces and to any unbonded pieces which can be protected from slipping.

Limitations

1. This shape factor is limited to pieces having parallel loading faces and sides normal to these faces.

2. Narrow, thin strips will be somewhat softer than shown by Figs. 13 and 14 but all other shapes studied (within the limits of the previous paragraph) conform closely to these curves.

3. Obviously a compression piece must be kept within the limits of stability. Ordinarily a piece shoud not be thicker than its least width, but some cases where the percentage of compression is not high have been successful where the thickness is twice the least width.

4. Pieces with perforations must have the holes uniformly distributed over the whole area. If a piece with non-uniform perforation were required, it would be necessary to consider it as several pieces, calculating each one and assembling the data.

5. For large shape factors the surface becomes increasingly important. Accidental lubrication in service may interfere with correct compression values. Bonding the rubber to metal plates is usually the best and often the only solution where large shape factors are needed. In this connection any slippage on the metal plates of pieces not bonded may result in abrasion of the rubber. Keeping the shape factor low is usually good practice, but shape factors below 0.25 may permit buckling. Therefore, the usual practical range of shape factors as here defined is from 0.25 to 1.0.

6. We have assumed, without experimental data, that with tapered or conical sections, the shape factor can be approximated by taking the ratio of the average of the two loading faces to the total free area. Cylinders loaded on their sides, spheres, rings loaded radially have not been checked. Irregular shapes, including those in which a progressively larger area contacts the loading plates and those to be used with curved or warped loading plates are usually solved only by trial and error. However, even in these cases, a rough approximation from these charts may be useful.

7. The individual tests were made with a good degree of precision, but when results are assembled in relation to durometer hardness, this degree of precision is not retained.

8. While for the above reasons it continues to be necessary to check results in actual use, the charts will be found satisfactory for preliminary designs.

With the forthcoming improvement in stiffness and hardness measurement technique, it should be possible to refine the accuracy of these charts. In any event, it would seem that the method of presentation in this paper should be applicable to further work on the subject.

A Study of Methods of Testing and Chemical Analysis of Metallic Driers

By W. T. Pearce[1]

EDITOR'S NOTE.—This paper describes certain of the methods used in the cooperative test program to develop a standardized method of testing driers, the new methods having been approved at the annual meeting on the recommendation of Committee D-1 on Paint, Varnish, Lacquer, and Related Products, and issued under the designation D 564 – 40 T.

DILUTE SOLUTIONS of metallic driers are distributed widely as liquid driers. Important consumers of these materials are the Federal Government, railroads, paint manufacturers, and master painters. In spite of the large quantities of such materials purchased, the Society has no specifications covering them, and the Federal Government has only one, TT-V-651, which was issued in 1931. The function of these driers and the various methods of test were described in an article published in the BULLETIN last year.[2] In this article a program of work was outlined for Subcommittee IX on Varnish of the Society's Committee D-1 on Paint, Varnish, Lacquer, and Related Products. The personnel of the group selected for this work consisted of:

C. C. Hartman, National Bureau of Standards
C. J. W. Wilt, Pratt & Lambert, Inc.
Joseph Mattiello, Hilo Varnish Corp.
Arthur Minich, Vice-President, Nuodex Products Co., Inc.
W. T. Pearce, Resinous Products and Chemical Co., Inc.
R. E. Troutman, Research Division Head, Krebs Pigment and Color Corp.
G. G. Unkefer, The Harshaw Chemical Co.

Five typical samples were carefully prepared and distributed to the members of this group. These consisted of liquid driers, in relatively dilute solutions, of lead and manganese naphthenate, lead and manganese linoleate, cobalt resinate, cobalt oilsolate, and zinc naphthenate.

The general examination consisted of determining the appearance, color by several methods, nonvolatile matter, miscibility with raw linseed oil, and rate of drying of a blend consisting of one volume of drier to nine volumes of linseed oil.

Chemical Analysis:

After a consideration of a large number of systems, the most promising for each metal were selected. These included two methods for the determination of lead, three for manganese, and two each for cobalt and zinc. These methods were classified as A, B, and C.

Method A.—In the determination of lead, organic matter is destroyed by the use of nitric and sulfuric acids and the lead separated and weighed as lead sulfate. Manganese is determined by fusing a separate sample which has been freed of all organic matter with potassium pyrosulfate, dissolved and precipitated as the phosphate in the usual manner. In the case of

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelpia, Pa.

[1] Chairman, Subcommittee IX on Varnish, Committee D-1.

[2] W. T. Pearce, ASTM BULLETIN, October 1939, p. 31.

TABLE I.

	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5
Report No. I					
Appearance Condition in container	Clear No separation	Cloudy Appreciable settling and separation	Clear Slight separation and settling out	Clear No separation	Clear No separation
Nonvolatile matter	5.5%	100%	4.4%	100%	60.6%
Color of drier[a]	No. 18	No. 18	No. 13	No. 18	No. 6
Color with oil (1:8)	No. 16	No. 15	No. 11	No. 13	No. 11
Miscibility with oil (1:19)					
1 hr.	No curdling	Cloudy	No curdling	No curdling	No curdling
24 hr.	No curdling	Appreciable curdling	No curdling	No curdling	No curdling
Drying time	7 to 18 hr.	7 to 18 hr.	7 to 18 hr.	7 to 18 hr.	30 to 40 hr.
Report No. II					
Appearance Condition in container	Clear No settling	Cloudy Some settling	Clear No settling	Sl. Cloudy Some settling	Clear No settling
Nonvolatile matter	6.66%	100%	4.49%	100%	61.0%
Color of drier[b]	No. 9	No. 10	No. 7	No. 10+	No. 3
Miscibility with oil (1:19)					
1 hr.	Cloudy	Cloudy	Clear	Clear	Clear
24 hr.	Separation	Separation	Clear	Clear	Clear
Drying time	22 hr.	22 hr.	22 hr.	22 hr.	40 hr.
Report No. V					
Appearance Condition in container	Hazy O.K.	Settled and suspended matter Suspended matter	Clear O.K.	Clear O.K.	Clear O.K.
Nonvolatile matter	6.79%	98.4%	4.51%	99.2%	59.3%
Color of drier[c]	9L-9	9L-Opaque	7L	9+	2L-2
Color with oil (1:8)	7L	5L-5	5L-5	5	4L-4
Miscibility with oil (1:19)					
1 hr.	Clear	Hazy	Clear	Clear	Clear
24 hr.	Clear	Clear with settlement	Clear	Clear	Clear
Drying time	32 hr.	32 to 40 hr.	32 hr.	32 hr.	32 to 40 hr.
Report No. VI					
Appearance Condition in container	Clear O.K.	Cloudy with separation Separation	Clear O.K.	Clear O.K.	Clear O.K.
Nonvolatile matter	6.7%	100%	4.5%	100%	65.2%
Color of drier[d]	3	...	...	...	0.05
Color with oil (1:8)	0.6	0.6	0.6	0.6	0.6
Miscibility with oil (1:19)					
1 hr.	Clear	Cloudy	Clear	Clear	Clear
24 hr.	Clear	Cloudy	Clear	Clear	Clear
Drying time	10 hr.	16 hr.	14 hr.	14 hr.	..

[a] Gardner System—1933.
[b] Gardner-Holdt.
[c] Hellige-Klett.
[d] Dichromate.

TABLE II.—RESULTS OF ANALYSES OF DRIER SAMPLES.

Report	Sample No. 1 (New Type)					Sample No. 2 (Old Type)					Sample No. 3 (New Type)		Sample No. 4 (Old Type)		Sample No. 5	
	Lead, per cent		Manganese, per cent			Lead, per cent		Manganese, per cent			Cobalt, per cent		Cobalt, per cent		Zinc, per cent	
	Method A	Method B	Method A	Method B	Method C	Method A	Method B	Method A	Method B	Method C	Method A	Method C	Method A	Method C	Method A	Method B
No. I	1.87	1.45	0.27	0.15	0.19	2.02	1.38	0.28	0.15	0.19	0.77	0.68	0.68	0.44	7.69	7.44
No. II	1.91	1.84	0.20	0.17	0.20	2.12	1.99	0.25	0.18	0.21	0.66	0.53	0.58	0.52	7.81	6.27
No. III	1.89	1.91	0.21	0.19	0.17	2.13	2.12	0.23	0.21	0.18	0.60	0.66	0.55	0.59	7.62	7.66
No. IV	2.01	2.08	0.27	0.21	0.22	1.86	1.90	0.20	0.19	0.19	0.82	0.84	0.72	0.79	7.65	7.16
No. V	1.86	1.77	0.37	0.18	...	2.08	1.94	0.38	0.15	...	0.79	0.61	0.75	0.59	7.61	7.21
No. VI	2.05	...	...	0.21	0.19	1.98	...	...	0.22	0.20	0.59	...	0.69	...	8.06	7.97
No. VII	1.89	1.40	0.24	0.14	...	2.20	1.68	0.27	...	0.19	...	...	...	...	...	...

cobalt, organic matter is destroyed by ashing and subsequent fusion with potassium pyrosulfate. The cobalt is extracted from the fused mass and precipitated with nitroso-beta-naphthol. For the determination of zinc, the sample is extracted with hydrochloric acid and mineral spirits. The soluble zinc salt is then removed and titrated with potassium ferrocyanide, using an external indicator.

Method B.—The sample of drier is heated to remove most of the solvent. The metals are extracted with hydrochloric acid and the liberated organic acids absorbed in beeswax. To the soluble chlorides ammonium sulfide is added to precipitate the drier metals. To the sulfides are added nitric and hydrochloric acids and the lead removed and weighed as lead sulfate. To a part of the filtrate from the lead sulfate, ammonium persulfate is added to oxidize the manganese to permanganic acid, which is then titrated with a standard vanadyl sulfate solution. Another portion of the filtrate from the lead analysis is used for the determination of zinc, which is precipitated with hydrogen sulfide and the sulfide ignited to zinc oxide.

Method C.—Alternative procedures for determination of manganese and cobalt were included and designated as method C. Organic matter is removed by ashing in the usual manner and samples of the ash are used for determining manganese and cobalt. For determination of manganese, the sample is dissolved and the manganese oxidized to permanganic acid with sodium bismuthate and titrated with ferrous sulfate by the usual method. For cobalt a sample is dissolved in nitric acid. To remove all of the nitric acid, cobalt is precipitated with sodium hydroxide. It is then dissolved in acetic acid and precipitated with nitroso-beta-naphthol as in method A.

The methods in detail are given in the Appendix.

Results:

The data secured by the several workers are given in Tables I and II. The data given in Table I indicate that the methods for general examination are satisfactory with the exception of drying time. Attempts will be made to define more accurately the stage of drying which is to be recorded. A study of Table II shows that much better agreement is secured with method A for the determination of lead. It also offered less difficulty to the majority of the workers. This applies to both types of driers. In determination of manganese, the best agreement was secured by the use of method C which cannot be used when cobalt is present. Good agreement was secured with method B. Rather wide variation was noticed in the results secured with both methods for determining cobalt.

After careful consideration of the data and the opinions of the several workers, it was decided that the following procedures be recommended as tentative methods of test:

For lead, method A; for manganese, method B with method C as an alternative method when cobalt is absent; for zinc, method A.

It was decided that further work on the determination of cobalt was desirable. This includes electrolytic methods. Later on methods for the determination of other drier metals will be studied.

Appendix

METHOD A

DETERMINATION OF LEAD

Weigh by difference (using a dropping bottle) about 5 g. of the sample into a 400-ml. beaker with Speedyvap cover (or use a homeopathic vial of the size of a Gardner-Holdt tube in which to weigh the sample and transfer it to the beaker). Heat on a hot plate until the solvent is removed. Add about 5 ml. of concentrated HNO_3 and 40 to 50 ml. of (H_2SO_4 50 per cent). Heat until dense white fumes come off (SO_3) and continue until about 5 ml. of acid remain. If the solution turns dark, add very carefully, by means of a dropping bottle, a few drops of concentrated HNO_3. Repeat this process until white fumes come off and the solution stays clear. Allow to cool, then add carefully a few milliliters of H_2O_2 (30 per cent). Boil for 1 min., cool, then add carefully about 100 ml. of distilled water, and put on a hot plate for a few minutes to allow crystals to coagulate. Filter through a Gooch crucible, previously prepared and heated to constant weight, wash with H_2SO_4 (0.5 per cent), then with a little alcohol. Place the crucible in a muffle furnace and heat for 15 min. at a dull red heat (not over 600 C.), cool, and weigh as $PbSO_4$.

$$\text{Lead, per cent} = \frac{\text{wt. of } PbSO_4 \times 0.683}{\text{wt. of sample}} \times 100$$

DETERMINATION OF MANGANESE

Weigh by difference about 5 g. of the sample into a large crucible. Place on a stone slab on the base of the hood. Play the flame of a burner upon the surface of the sample, and allow to burn quietly until most of the organic matter is destroyed. Transfer to a muffle or heat over the flame at a dull red heat until all carbonaceous matter is removed. Add approximately 5 g. of potassium pyrosulfate in small amounts and heat carefully after each addition to avoid spattering. Cover the crucibles with lids during entire fusion operation. Finally heat for about 10 min. with full flame to insure complete fusion; then cool.

When cool, place crucible and lid into a 600-ml. beaker and add about 300 ml. of distilled water. Boil until fusion mass has been completely leached out, usually requiring about 15 min. Filter, and wash beaker and contents with water. Cool, and add 20 g. of NH_4Cl and 1 to 2 g. of diammonium phosphate ($(NH_4)_2HPO_4$). Heat to boiling, clear the solution with dilute HCl if necessary, then add concentrated NH_4OH, drop by drop with constant stirring. As soon as a precipitate appears, stop the addition of NH_4OH, and boil as before; continue until no more precipitate is produced and the silky appearance of the precipitate is unchanged. Finally add 0.5 ml. of NH_4OH in excess and allow the solution to

cool, preferably in ice water. Let stand for 2 to 3 hr., and filter on an ashless paper. Wash with cold, faintly ammoniacal solution of NH_4NO_3 (10 per cent) until chlorides are removed. Dry at gentle heat, ignite at as low a temperature as possible until the carbon is destroyed, then heat at approximately 1000 C. (a Fisher burner may be used) to constant weight. Weigh as $Mn_2P_2O_7$ (Note).

$$\text{Mn, per cent} = \frac{\text{wt. of } Mn_2P_2O_7 \times 38.69}{\text{wt. of sample}}$$

NOTE.—This procedure for determination of manganese is based on the precipitation in a slightly ammoniacal solution containing an excess of ammonium salts. Final precipitation should not be allowed to proceed for longer than 4 hr.; otherwise, high results are the rule.

DETERMINATION OF COBALT

Weigh by difference about 5 g. of the sample into a large crucible. Ash as in the method for manganese. After complete ashing, add 5 to 10 g. of potassium pyrosulfate ($K_2S_2O_7$), and heat until the fusion is completed. This is best accomplished by heating gently until bubbling ceases, then with the full flame of the burner. When the molten mass attains a cherry-red heat, swirl the crucible gently, by means of crucible tongs, until homogeneous.

Cool the crucible to room temperature and extract the fusion mass with 50 to 100 ml. of hot distilled water containing 1 to 2 ml. of H_2SO_4 (50 per cent). Filter through a fine filter paper to remove insoluble sulfates, carbon, etc., and dilute with distilled water to 500 ml. in a volumetric flask.

To 25 ml. (pipetted) of the above solution, add 10 drops of H_2O_2 (30 per cent), one or two drops of phenolphthalein test solution, and then enough 0.5 *N* NaOH to precipitate the cobalt completely and obtain an alkaline reaction with the indicator present. Add 20 ml. of glacial acetic acid, and heat gently; then add one or two drops of H_2O_2 (30 per cent), and continue heating until the $Co(OH)_3$ is dissolved. Filter at this point, even though no insoluble material is apparent. Dilute to from 200 to 250 ml. with water, heat to gentle boiling, and add 15 ml. of a freshly prepared, hot solution of nitroso-beta-naphthol, made up as follows:

Dissolve 2 g. of nitroso-beta-naphthol (Merck's reagent quality, approved for cobalt determinations) in 50 ml. of hot glacial acetic acid. Add 50 ml. of hot distilled water and filter. (This reagent will not precipitate Ni or Mn.)

Stir until the precipitate coagulates, and allow to stand for 2 hr. at 60 C. Decant the supernatant liquid into a prepared Gooch crucible. Add 75 ml. of a hot acetic acid solution (33 per cent) to the precipitate remaining, stir, and continue filtering the entire precipitate on the Gooch crucible. Wash the precipitate on the crucible 4 to 6 times with hot (60 C.) acetic acid solution (33 per cent) and then the same number of times with hot water. During the filtering operation, the filter cake must not be allowed to crack.

Dry the crucibles at 125 to 130 C. for 3 hr., cool, and weigh.

$$\text{Metallic cobalt} = Co(C_{10}H_6(NO)O)_3 \cdot 2H_2O \times 0.09649$$

$$\text{Cobalt, per cent} = \frac{\text{wt. of ppt.} \times 192.98}{\text{wt. of sample}}$$

DETERMINATION OF ZINC

Weigh accurately, to four decimal places, 10 to 15 g. of the sample into a 250-ml. Erlenmeyer flask. Dilute to a volume of 50 to 70 ml. with petroleum spirits and shake vigorously with 15 ml. of concentrated HCl and 30 ml. of distilled water. Pour the contents of the flask into a 500-ml. separatory funnel and drain the lower aqueous layer into a beaker. Repeat the above extractions twice, using half the amount of acid and water. Finally wash with 30 ml. of water, collecting the lower layers in a beaker. Dilute to 500 ml. in a volumetric flask.

Pipette accurately 50 ml. of the acid solution into a beaker, dilute with 50 ml. of water, make slightly alkaline with NH_4OH and then add exactly 3 ml. of concentrated HCl. Heat to about 80 C. and titrate with standard potassium ferrocyanide solution, using uranium nitrate solution (10 per cent) as an external indicator. The desired end point is a brown tinge obtained by adding a drop of the titrated solution to a drop of the indicator on a white glazed tile.

The standard potassium ferrocyanide solution contains about 40 g. of the salt per 1000 ml. of solution. This solution should be allowed to stand for about a month before using. For standardization, follow the above method, using about 0.2 g. of pure zinc for a titration.

METHOD B

METHOD OF SEPARATION OF METALS FROM ORGANIC MATTER

Weigh 5 g. of solid or paste driers or 10 g. of japan driers into a 200-ml. tall-form beaker. Heat the japan driers just high enough to evaporate most of the volatile thinner, avoiding temperatures above 200 C. before proceeding with the following double decomposition.

Add 100 ml. of HCl (20 per cent) and 5 g. of beeswax, then warm just below the boiling point, and stir occasionally to aid double decomposition. Reaction starts immediately, but about 1 hr. is usually required to completely liberate the fatty acids or whatever other organic acid may have been used in preparing the drier. The liberated acids rise to the surface as a clear yellow oily layer, while undecomposed particles settle to the bottom. The wax serves to absorb the liberated organic acids; upon cooling, the mixture solidifies and thereby enables separation by filtration. When decomposition is complete, thorough agitation is advisable so that all the more or less emulsified organic acids may be extracted by the molten wax. Cool to room temperature, remove the solidified wax, and wash with a stream of water. Filter off the remaining particles of wax, and wash to dissolve lead chloride (if much lead was originally present) and other drier metals. Make the filtrate distinctly ammoniacal, and precipitate the metals with colorless ammonium sulfide. Digest to coagulate the insoluble sulfides, filter, and wash with diluted colorless ammonium sulfide. Reserve the filtrate for a calcium determination and the sulfide precipitate for the other drier metals.

DETERMINATION OF LEAD

Transfer the paper from above separation, containing the sulfide precipitate, to a 250-ml. beaker and add 10 ml. of concentrated HNO_3 and 5 ml. of concentrated H_2SO_4. Cover the beaker and slowly evaporate to fumes. Usually this treatment is sufficient to oxidize the organic matter, but if charring occurs after strong fuming, add a few milliliters more of HNO_3 and again evaporate to fumes. Wash cover and beaker sides with water and evaporate to fumes. Repeat to insure complete removal of HNO_3. Add 100 ml. of water and digest on hot plate to insure complete solution of the anhydrous sulfates of other drier metals. Let stand at room temperature several hours, then filter through a tared Gooch crucible and wash with H_2SO_4 (5 per cent), followed by one washing with cool water. (Save filtrate for other metals.) Heat crucible in muffle at dull red heat for 15 min., cool, and weigh as $PbSO_4$. Filter, and use filtrate for the determination of manganese.

DETERMINATION OF MANGANESE

Prepare the standard vanadyl sulfate solution by dissolving 12 g. of ammonium vanadate (chloride free) in 400 ml. of hot water. Add 10 g. of sodium acid sulfite followed by 20 ml. of concentrated H_2SO_4. A clear blue solution should result. If a precipitate forms, digest until dissolved. Concentrate by brisk boiling to remove the last traces of excess sulfur dioxide, cool, and dilute to 1 liter. Standardize against 0.1 *N* permanganate. Best practice is to measure off the permanganate into a 500-ml. boiling flask, dilute to 300 ml. with water, and acidify with 7.5 ml. each of concentrated H_2SO_4 and 85 per cent phosphoric acid. Titrate rapidly with the vanadium solution until the permanganate color changes to a faint pink color. Continue the titration drop by drop, allowing about 10 sec. between drops, until a clear yellow develops. The solution is then used as a reference color standard, because many shades of yellow are possible and therefore a reference standard should always be used. Reduction of the measured permanganate followed by reoxidation according to the procedure does not yield a sufficiently permanent end point to serve as a color reference because of slow reoxidation of manganese due to the presence of silver and persulfate. The standard vanadium solution is quite stable toward light and air.

To the filtrate from the lead determination add 7.5 ml. of 85 per cent phosphoric acid, and dilute to about 150 ml. Add 10 ml. of 0.1 *N* silver nitrate for each 0.05 g. of manganese present, and 3 g. of ammonium persulfate dissolved in about 15 ml. of water. Heat to just below the boiling point until a permanganate color fully develops. During the heating, various color changes may be observed; pale pink, brown, red, and permanganate color. If a brown precipitate is formed that does not clear by the time the boiling point is reached, too much manganese is present. If the color does not change beyond a red color, too much acid is present. If the brown precipitate forms, the solution may be reduced with sulfurous acid, diluted to volume, and aliquoted; if the red color does not change to permanganate color, start another sample. It should be remembered that 5 per cent of H_2SO_4 and 5 per cent of phosphoric acid should not be exceeded. It should also be remembered that prolonged heating may destroy all the excess persulfate, which would cause low results. Remove the solution from the heat source just as soon as the permanganate color fully develops, add 150 ml. of water, cool to below 20 C., and titrate with the vanadium solution, as described for standardization, to the same yellow color as obtained for standardization.

DETERMINATION OF ZINC

Use the ordinary beeswax method given above for separating the metals and proceed as with lead, evaporating to fumes several times to remove all HNO_3, etc. Then add 50 ml. of water and warm to dissolve salts. Cool to at least room temperature, neutralize filtrate with NH_4OH, and treat with ammonium sulfide. Digest hot to coagulate the zinc sulfide, filter, and wash moderately with dilute ammonium sulfide. Ash and ignite below 800 C. to constant weight and weigh as the oxide.

METHOD C

DETERMINATION OF MANGANESE

Weigh by difference about 20 g. of the sample into a large crucible. Place on a stone slab on the base of the hood. Play the flame of a burner upon the surface of the sample, and allow to burn quietly until most of the organic matter is destroyed. Transfer to a muffle and heat at a dull red heat (not over 600 C.) until all carbonaceous matter is removed. After cooling in a desiccator, weigh the crucible and contents and calculate the percentage of ash. Calculate the percentage of ash in the sample. Now grind and thoroughly mix the ash in the crucible.

Accurately weigh between 30 and 50 mg. of the ash into a 250-ml. beaker. Add, drop by drop, about 5 ml. of a saturated solution of sulfur dioxide and digest on a steam bath until the ash is completely dissolved.

Add 50 ml. of HNO_3 (sp. gr. 1.135) (about 1 part concentrated HNO_3 to 2.1 parts of water). Boil to remove the excess sulfur dioxide. Remove from the hot plate, add a small amount of sodium bismuthate, and boil for a few minutes. Again add sulfur dioxide solution drop by drop until the solution becomes colorless, and boil to remove the excess sulfur dioxide. Remove the beaker and contents from the hot plate and cool in iced water until the temperature of the solution reaches 15 C. or slightly lower. Now add about 2 g. of sodium bismuthate, allowing the beaker and contents to remain in the iced water for at least 10 min. Add 50 ml. of HNO_3 (3 per cent), filter through an asbestos pad, and wash the residue with cool HNO_3 (3 per cent) until free from permanganic acid.

Add enough standard ferrous sulfate solution to reduce all of the permanganic acid and to require approximately 10 ml. of permanganate in the back titration. Stir thoroughly until the permanganic acid is decolorized. Titrate at once with 0.1 *N* $KMnO_4$ to the usual end point. Carry a blank determination through all steps of the method, add the same amount of ferrous sulfate as used for the sample, and titrate with permanganate. The difference between the titrations of the sample and blank represents the permanganate equivalent of the permanganic acid formed in the test, and the amount of manganese is calculated from the manganese titer of the permanganate solution.

$$\text{Mn, per cent} = \text{Percentage Mn in ash} \times \text{percentage ash in sample}$$

DETERMINATION OF COBALT

Accurately weigh into a 250-ml. beaker, a sufficient quantity of the ash, as obtained in the method for manganese, to insure the presence of at least 1 mg. of metallic cobalt. Add 20 ml. of diluted HNO_3 (1 part concentrated acid to 5 parts of water) and several drops of hydrogen peroxide (30 per cent). Heat on a steam bath until solution is complete. Remove from the steam bath, cool, and add 5 ml. of concentrated H_2SO_4. Boil over a Bunsen burner until the HNO_3 is all expelled (usually boiling to copious fumes of SO_3 will be sufficient). Dilute to 100 ml. with distilled water, add 10 drops of hydrogen peroxide (30 per cent), and several drops of phenolphthalein indicator. Now add enough 0.5 *N* NaOH to precipitate the cobalt completely and obtain an alkaline solution with the indicator present. Then proceed as in method A for cobalt, beginning with the third paragraph, second sentence.

$$\text{Co, per cent} = \frac{\text{wt. of ppt.} \times 192.98 \times \text{percentage of ash}}{\text{wt. of sample}}$$

The Technique of Inspecting Wood Poles by X-ray[a]

By Myron Zucker[1]

There are several million wood poles in electric utility services in this country. Their steady deterioration is a major problem, since hundreds of thousands must be replaced each year before they become hazardous. Fungus rot near the ground line is the major source of danger. Because of this, many utilities employ men who are familiar with poles, to "test" their condition periodically. Usually these men depend upon their experience, aided by sounding, boring, or prodding to decide which poles should be replaced. To overcome the evident limitations of this method, X-ray inspection of poles has been proposed. The idea is new and has yet to be proved by thorough trial, but certain advantages have been established by almost 3 yr. of work. It puts inspection on a scientific basis, gives permanent records, and does not injure the poles. It may also materially postpone replacement of many poles, eventually lengthen inspection periods, and give data on rate of internal pole rot. Several of these phases have been considered elsewhere,[2,3] and some will have to wait until the process has had further trial. This paper is concerned primarily with the development of the Roentgenological technique, and analysis of radiographs.

Development of X-ray Technique

In 1937, when X-ray inspection was suggested, we assumed that, if it worked at all, we would merely have to adapt some previously developed technique: make mechanical arrangements for a rugged, portable, practical field equipment, assure ourselves of accuracy and of electrical and radiological safety, and check the economy of the method. Inquiries showed, however, that although extensive work had been done on other materials, practically none was reported on wood. We had apparently opened a new field which would have to be fully explored. The number of possible entries as indicated by similar work in other applications, was almost bewildering. Fluoroscopy, radiography with film or with sensitized paper, scanning by instruments, and photofluoroscopy were all possible. In each case the correct combination of Roentgenological factors had to be found before the feasibility of the method could be judged.

Fluoroscopy:

Fluoroscopy was our first choice, on the theory (as assumed by Maloy and Wilsey[4]) that, since sound wood is expected to absorb more X-rays than rotten wood, the parts of the fluorescent screen behind the former would be in deeper shade than parts behind rotten or thin wood. Observation of a few hollow-hearted untreated Northern Cedar salvage stumps in the warehouse bore this out: heart rot, pipes, and surface rot could be distinguished by their brighter outlines. In a defective new Southern Pine, the course of heart rot could be traced from one end of the pole to the other. However, an attempt to duplicate such inspection in the field with several types of fluorescent screens built into viewing boxes was not so successful. The chief shortcomings were the physical difficulty of examining buried portions of poles and of keeping operators' eyes "accommodated" to intermittent outdoor screen viewing. Because of this, and for radiological safety, and to acquire film records, we turned to radiography.

Radiography—Diagnostic Elements:

Pictures of the same butts were taken on 14 by 17-in. films in the laboratory with Westinghouse Diadex and Fluoradex machines. These pictures showed the light and dark areas for sound and rotten wood, and, furthermore, had an additional diagnostic element that was later to save X-ray inspection from failure. This new element was the shadow of growth rings. Figure 1 shows diagrammatically why these appear. In section *A* each growth ring presents a considerable tangential length to the rays. Therefore this section acts like a laminated

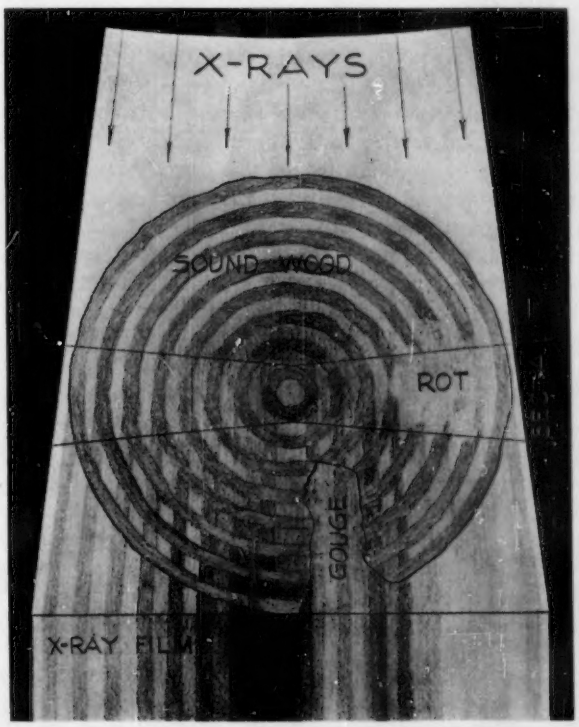


Fig. 1.—Diagram of Radiographic Pattern from Sound and Rotten Halves of Poles.

Darkness indicates less X-ray intensity. Film shading is reverse of actual image. Dark rings are summerwood, light rings springwood.

[a] Presented at the Forty-third Annual Meeting, Am. Soc. Testing Mats., Atlantic City, N. J., June 24–28, 1940.

[1] Engineering Division, The Detroit Edison Co., Detroit, Mich.

[2] "X-ray Pole Inspection a New Engineering Tool," *Electrical World*, Vol. 113, March 23, 1940, p. 882.

[3] Inspection of Electric Utility Poles, *Minutes* of Transmission and Distribution Committee of Edison Electric Institute, May 8, 1940.

[4] T. P. Maloy and R. B. Wilsey, "X-raying Trees," *American Forest*, Vol. 36, February, 1930, p. 79.

block, the shadow of which appears on the film. These "grain" lines are smooth, straight, clear-cut, uniform, when the wood is sound (left side of diagram). When the pole is hollow (right side of pole) the lines do not appear on the film behind the missing portion. In intermediate cases of weak, stringy wood, the lines appear—but are distinctly different; edges wobble, the width of each ring varies, lines merge or fade, each fiber is discontinuous. Breakdown is perceptible, even in fairly early stages. Figure 2 is a reproduction of a pole in which this difference appears.

Keeping Within Range of Film Densities:

This radiograph (Fig. 2) was taken at 85 kv. p. with intensifying screens but no grids. A $^1/_8$-in. lead sheet was moved into the field at intervals, to vary exposure time. It illustrates one difficulty: although diagnosis was clear in those portions of the film having proper density, the great difference in pole thickness made it impossible to expose pole edges and center correctly on the same film. An exposure range of 32 to 1 was often indicated. (Dosimeter readings on a typical pole showed 14 Roentgens per minute at outer edges, and one Roentgen per minute at the middle.) Increasing X-ray voltages had but little effect. Results were appreciably improved by use of the less contrasty Agfa non-screen film. Detail was fairly good over small, dry, salvaged poles, but not on large moist poles in the field.

To overcome this difficulty, we considered the usual types of builtup shields, lead screens, and also devices to vary exposure time or beam intensity over various parts of the pole. None of these devices appeared to produce desired results and still be mechanically satisfactory for field work.

Only the first-named method was explored in some detail. An aluminum step-wedge was used to determine what thickness of metal would compensate for the shorter path of wood at the outer edges of several poles. From these data, aluminum filters (stationary and movable) were designed to get the equivalent of building the pole up to a square shape, and attached to the "calipers" upon which the X-ray machine was mounted. Results were in the right direction, but the arrangement was mechanically "touchy." Because of different pole sizes, shapes, and degrees of rot, no simple mechanism would give sufficient correction in all cases.

Finally, we conceived the idea—which has been adopted for general use—of wrapping a thickness of rubber tire inner-tubing around the pole. One tube that we have found to be satisfactory for most work is about 0.1 in. thick, with the following X-ray absorbent constituents: 5 per cent zinc oxide (ZnO), 5.1 per cent magnesium oxide (MgO), 2.4 per cent ferric oxide (Fe_2O_3), 1.3 per cent aluminum oxide (Al_2O_3), 1.2 per cent silica (SiO_2), and 1.1 per cent aluminum silicate ($3\ Al_2O_3 \cdot 2SiO_2$) by weight of original rubber. The metallic elements in the rubber absorb rays, bringing the outer edges of the pole image to the same range of density as the center. Its effectiveness may be judged by the following table which compares rubber thickness with thickness of Northern Cedar (air-dried for 15 yr.) that will pass the same percentage of rays at 85 kv. p.

Inches of rubber	0.1	0.2	0.3	0.4
Percentage of 85 kv. p. rays passing through	35	20	13	9
Inches of Northern Cedar to absorb same amount	1.6	2.7	4.4	7±

We use this tubing on all but very small poles and can almost always see the complete image from edge to edge.

Effect of Secondary Radiation:

When considering X-ray voltage, we were warned that even at the relatively low value of 85 kv. p.—the upper limit of portable X-ray units—secondary radiation would be excessive; we would either have to use low voltages—and long exposure times—or use grids to eliminate the anticipated great amount of "secondary." It was a surprise, therefore, to find that at 85 kv. p., "secondary" was sufficiently limited by simply restricting the main beam to just cover the film. The remaining fog did not obscure the detail needed for interpreting the films (although similar fogging might be objectionable in medical work where isolated and sometimes faint images are vitally important). We made a sufficient number of tests with Bucky and Lysholm grids to be assured that they were not needed. We therefore adopted 85 kv. p., non-screen radiography without grids.

Fig. 2.—Radiograph of Pole with Heart Rot—85 kv. p. Intensifying Screens, No Grids or Shields.

Various exposures. Short exposures show detail at pole edges; longer exposures gradually bring clear portion toward center of pole. Wet rot (where numbers are printed) not detailed even at maximum exposure.

A thin sheet of aluminum or lead foil in front of the film clarifies it somewhat but does not materially aid diagnosis. Because it is inconvenient to hold the foil—especially since we use paper-wrapped film—we have not made it a practice.

Exposure Time:

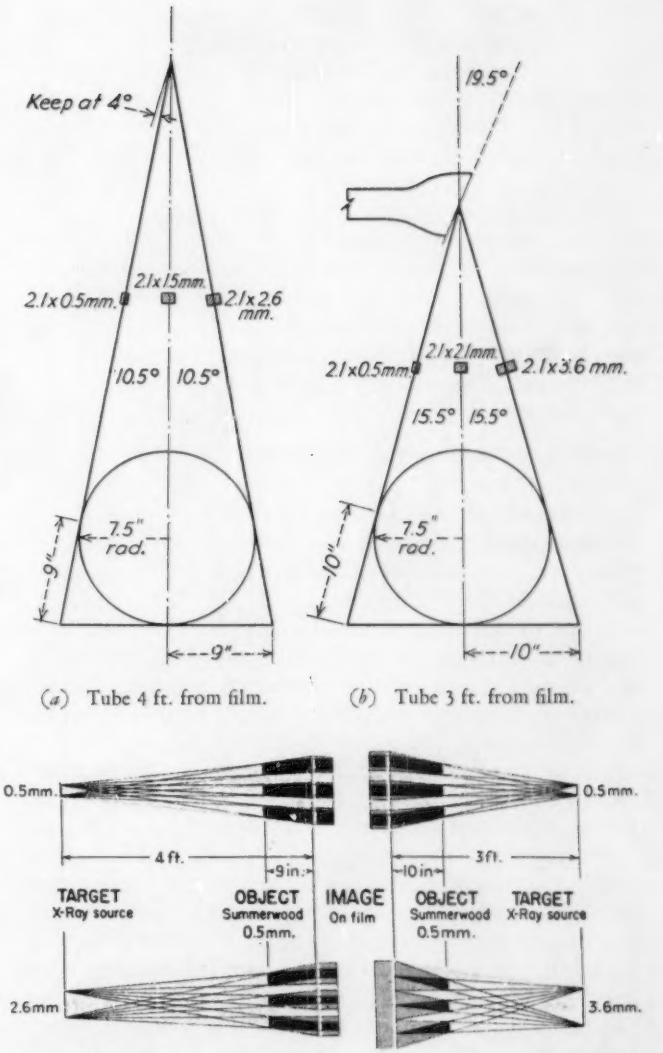
Through all this experimentation, an ever-present problem has been the determination of exposure times to bring the film to its proper density. We derived a curve of exposure time *versus* pole circumference by radiographing several stumps in laboratory or warehouse, in a manner similar to Fig. 2—and choosing optimum exposure for each. However, the curve was inaccurate in the field, due to additional variables: moisture, degree of rot, species, treatment, wood density, and probably several unknowns. Even renewal of burned-out X-ray tubes and change of power source (such as we have had, from central station supply to rotary converter and to a-c. generators of 1 to 2 kw. and 50 to 60 cycles capacity run by large and small gasoline-driven engines) required "recalibration."

The very nature of the problem makes it impossible to measure all the variables needed to determine optimum exposure—and it would be impractical even if possible. Therefore, although we have always been guided by a curve of exposure time *versus* pole circumference, the major variable, we have had to "take up the slack" by either varying film development time, by using lights of different intensities when interpreting the pictures, or by simply making the best of what we have. We are now working on an exposure meter that will be reasonably accurate, inexpensive, light in weight, and rugged. No commercially available apparatus meets all these requirements.

Distance—Target Size Effect:

In the early stages we standardized on a 3-ft. tube-film distance, to keep the equipment compact and exposure time within reason, and to minimize digging to reach the rottenest portion of the pole. After we had solved the problems already mentioned, it became noticeable that one side of all films was clear and distinct, whereas the other side was blurred or solid gray. This was shown to be the effect of too large a projected focal spot on one side of the film. The generator had a 2.1-mm. focal spot and was used with tube axis horizontal, so that the long dimension of the target insert went crosswise of the pole grain. The projected width at one side of the film was often 4 mm. or more. Geometrical investigation showed that excessive penumbral areas could often be obtained with the 2.1-mm. focal spot on the Diadex tube, combined with the 0.5-mm. width of summerwood and springwood bands often found on Northern Cedar poles. Figure 3 shows this diagrammatically. A 90-deg. change of tube position was not much of an improvement; although it brought out the fibers on the previously missing side, the effective target was larger than before for the major part of the film, and so there was a disagreeable fuzziness throughout.

The solution, as shown in Fig. 3 (*c*), is to increase the tube-film distance to 4 ft. The marked improvement in clarity is evident in the radiograph taken at 4 ft., Fig. 4. The greater distance has the additional advantage of reducing distortion. We find the equipment still manageable in the field, and exposure times not excessive—due partly to increased film speed made available in the years during which this work has been in progress.



(*a*) Tube 4 ft. from film. (*b*) Tube 3 ft. from film.

(*c*) Photographic analogy showing blurred outlines due to large source compared with object. Shadows are shown dark. Equivalent of 2.1 mm., 19.5 deg. target and section *A* of 15-in. diameter Northern Cedar pole, showing images on film at edges near heel (upper diagrams) and toe of target. Increased target—image distance projects umbral limit past film, partly due to equivalent object being closer to film.

Fig. 3.—Effective Target Sizes at Edges and Middle of 7.5-in. Radius Pole, and Resulting Images.

Other Record-Producing Methods:

Interspersed with the work on non-screen radiography, we have attempted to develop more economical means of examination. Radiographs were taken on X-ray paper—and even on ordinary photographic paper—before the rubber girth was used. Used with intensifying screens, the range of the paper was much less than that of non-screen film, and so there was always some part of the image that was either underexposed or overexposed to such an extent that all detail was lost. Without screens, exposure times were too long, and the paper was so sensitive to low-voltage rays that we had too much fuzziness

from secondary radiation. The prospect of having to furnish all the field inspection trucks with sufficient intensifying screens for a day's work (we want no darkrooms on the trucks at the present stage) has discouraged us from further trials, even though the use of rubber girths might bring us within the working range of the paper with screens.

Photographing various types of fluorescent screens has also been tried, but unsuccessfully. We have not wanted to devote the necessary time to developing this fine art until the method of X-ray inspection has proved itself. The attraction is, of course, low film cost, although this may be outweighed by high investment cost, bulkier and more delicate apparatus, and greater skill needed to obtain good pictures.

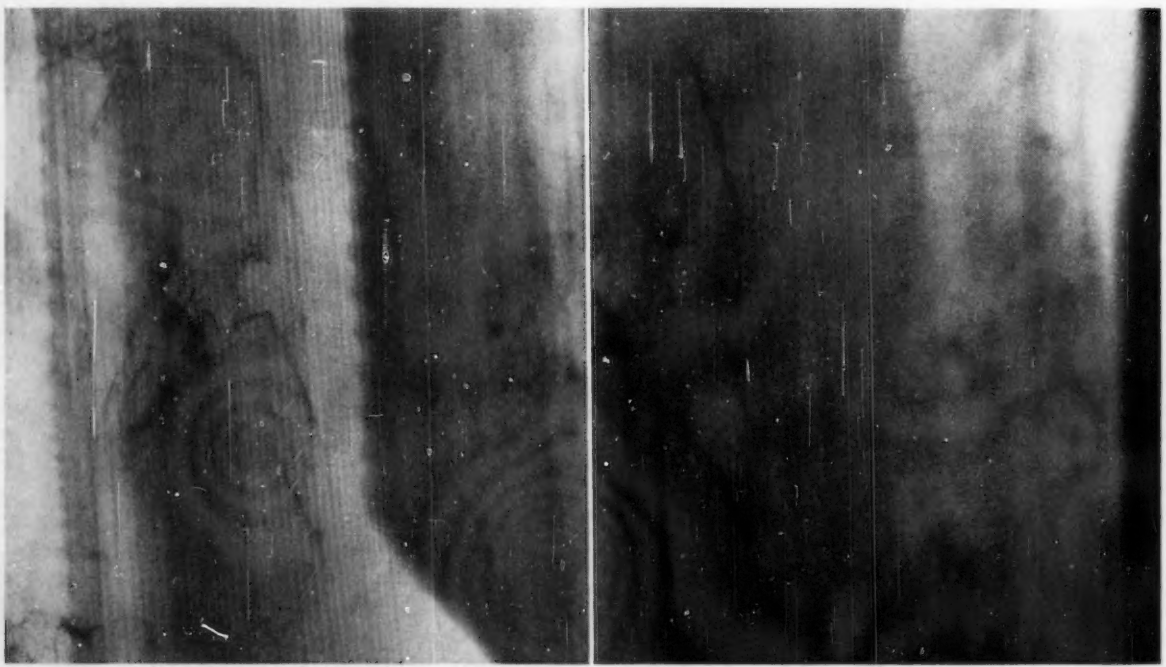
General Considerations of X-ray Technique as Applied to Wood Poles:

The discussion thus far concerns the major problems in the development of the X-ray technique. Summarizing, it may be seen that certain difficulties are found in the technique of X-raying poles: great thickness and great variation in thickness of the object, small difference in the density of parts to be distinguished within the object, need for only simple, sturdy accessories, relatively limited radiographic output of the rugged, portable generator that must be used, and the need for a mobile power supply. On the other hand, the technique of X-ray inspection is favored by several factors: the immobility of the subject and its immunity to deleterious effects from X-ray exposure, its similarity to humans for whom portable equipment has been designed, the intermittent nature of testing that makes for easy duty cycle on apparatus, and, above all, the cylindrical development of the wood that makes available a reliable diagnostic element, are all favorable. The latter, in particular, is a condition peculiar to this project. In addition, the fact that in most poles it is only necessary to take a picture at one place (near the groundline) and in the direction in which the cantilever load is applied to the pole is helpful. In safety to operators, too, there are advantages, since secondary radiation is relatively low due to lack of adjacent structures, operators can stand well away from the rays, and dosage tolerances are increased because of outdoor work.

Mobile Equipment

The methods resulting from the work previously described have enabled us to take X-rays of standing poles in the field accurately and with reasonable economy, by means of mobile equipment. A truck (Fig. 5) is equipped with portable X-ray machine and its controls, gasoline-driven 110-v., 60-cycle generator and 7 by 17-in. films. Accessories include a "caliper" X-ray stand, rubber girth, and digging tools. In the field, the truck is driven past the pole, dirt shoveled from the pole base for a foot or less, residue cleaned from the pole with a wire brush, rubber girth attached, X-ray machine moved to place on its "calipers," with the axis of the beam parallel to the line wires, and film placed parallel to the direction of the load on the pole, in grooves at the ends of the legs. Exposure time is decided upon, generator started and voltage adjusted properly, timer set, and the exposure made. Further details on these more general phases of the subject have been described elsewhere.[2]

There were two problems in designing the mobile equipment: one, whether the inverse voltage from small generators would be too high for the X-ray tube; and the other, whether tube life would be shortened too much by having high voltage applied to the filament before energizing the anode, that is, while the generator was lightly loaded. The oscillogram, Fig. 6, convinced the X-ray manufacturers that there was no danger due to inverse voltage. However, the filament voltage was much too high. We therefore installed a series resistor, and a con-



4 ft. 3 ft.

Fig. 4.—Radiograph at Edge of 13-in. Diameter Pole, Taken with 4- and 3-ft. Tube-Film Distance. (Full size.) Note Difference in Enlargement.

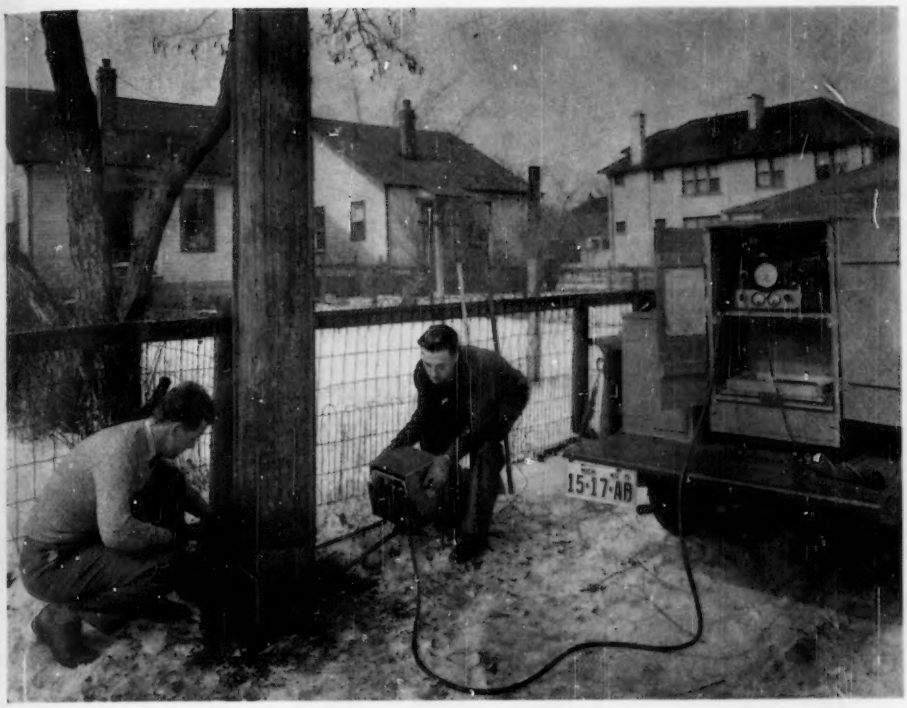


Fig. 5.—X-raying Pole with Mobile Equipment.

tactor to short-circuit the resistor when the timer button was pressed. This maintains practically constant voltage on the filament despite the great voltage drop on the small generator when heavy load is applied.

Analysis of Radiographs

With the exposures made, the next set of problems is in processing and interpreting films. Processing is done according to visual inspection practices rather than by the standardized X-ray time-temperature technique, because the uncertainty of exposure time makes us watch the films in the bath and use our judgment as to developing time. The problems of interpretation have been indicated in the discussion of technique, but a summary of how pictures are analyzed is in order, and also a short study of the geometry involved and our method of scaling off the pole strengths.

Detecting Rot:

The radiographs may be considered as a superposition of two images: one, a view of the fiber structure in the neighborhood of the pole diameter parallel to the film (section *A* in Fig. 1); two, an underlying picture of the amount of material (including moisture) in the whole pole. The analysis can be divided upon that basis. When fibers show clear, sharp, and uniform, the wood along the important diameter is sound. Any other condition of fibers means that the wood is weak, and probably should not be included in determining pole strength. We believe that by unevenness of shadow or by slight separation of fibers we can detect rot in such early stages that it is still imperceptible to sounding or boring.

This analysis may be supplemented if there are any noticeable changes in general gray tone of the radiograph. This supplementary interpretation is not only more difficult and uncertain, but generally of less value. It is complicated by the fact that rotten wood may absorb more or less X-rays than the same amount of good wood, depending on whether the rot is wet or dry. For the present discussion, we will assume that the rot is dry,

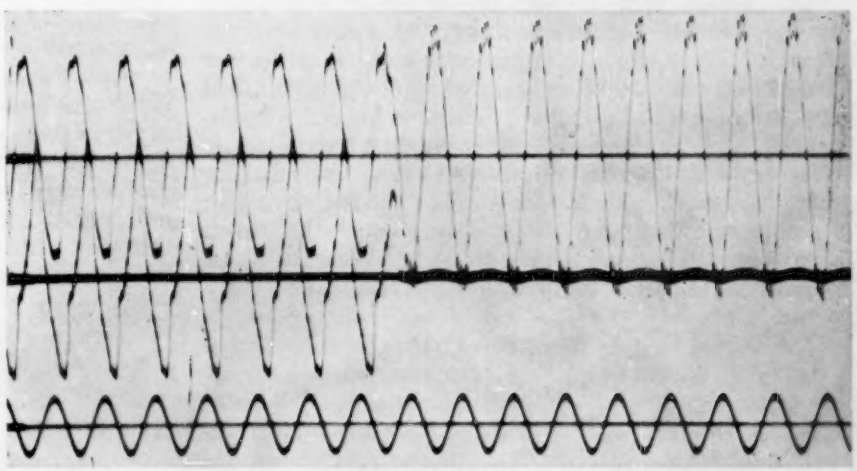


Fig. 6.—Oscillogram of 1.5 kw., 60 Cycle, Generator Output.

Top trace: voltage. Middle trace: current. Bottom trace: timing wave. At left, X-ray energized to 85 kv. p., 10 ma. $E = 110$ v., $I = 14.2$ amp. Inverse voltage peak = 1.07 times forward; inverse current = 0.68 times forward. At right only filament energized. $E = 150$ v.

remembering that effects may be reversed if it is wet. (See Fig. 2 in which center of heart rot is dry, but rim is wet.) Sudden changes of tone, representing appreciable differences in the amount of wood in the paths of adjacent increments of the X-ray beam, may be interpreted as follows:

1. Darkening near the edges (more than the usual gradual darkening due to cylindrical pole shape) means a gouge.

(*a*) If good fibers show in the darkened area, the gouge is "off-diameter" (that is, outside section *A*, Fig. 1).

(*b*) If fibers are ragged or missing, it may be assumed that the whole darkened section is rotten.

2. Large (over 1/2 in. wide) dark areas within the pole.

(*a*) Good fibers showing through indicate that the rot is off-diameter. Its importance may be judged from the width and intensity of the shadow. Negligible effect on pole strength unless rot is wide and deep.

(*b*) Poor fiber structure with moderate shadow is the common picture for heart rot. It may be assumed as circular in section, unless the shadow is so marked as to raise suspicions of unusual damage.

3. Small dark areas are either pipes, checks, or ant-cleared spaces which have no noticeable effect on pole strength unless they are widespread.

Other details—such as ant tunnels, knots, holes and plugs from previous boring tests—are evident on inspection, and are negligible.

Viewing boxes with adjustable masks and variable light intensity often permit detail of fibers to be seen in unusually dense or thin parts of the film.

We have made a set of instructional pictures, in which X-rays taken from two directions are compared with color-photographs of the end section of the poles. These describe better than words the superposition of fiber- and density-pictures, but are still not as effective as first-hand experience for learning how to diagnose radiographs.

Measuring Pole Strength:

Having analyzed the film, we must take two steps to determine pole strength. First, a picture of the good wood must be drawn (mentally at least) in a simple enough form to permit calculating the strength of the section. To do this, we assume that wood showing any degree of rot adds nothing to the strength of the pole, and that the good wood stands as a hollow cylinder. (Radiographs taken from several angles would give the major dimensions of all actual hollows, but the effort of making refined strength calculations would not be warranted. Other unknowns more than outweigh any theoretical improvement in accuracy that might be obtained. Tests referred to later show that the simplification is sufficiently correct.)

The second step in determining strength is to derive actual pole dimensions from film measurements. We assume that (*a*) the film is tangent to the pole at the neutral axis, and (*b*) the film is either flat or in a circular arc with the target as its center. (In the proportions encountered in practice, either shape yields practically the same numerical results.) The first assumption may sometimes be wrong, as when partially rotten sapwood separates film from outer useful fibers, but there is usually less than 5 per cent error.

On this basis, diameters may be read from the film and reduced to true dimensions considering the geometry shown in Fig. 1. If m is the radius of any given growth ring, as measured on the film, and r the actual radius of that same ring in the pole, the relation between them is

$$r = (D - R) \sin \tan^{-1} \frac{m}{D} = \frac{m\,(D - R)}{D}$$

where R is actual outside radius of the pole and D the tube-film distance. This shows that the enlargement ratio varies with pole size, and that the outer diameter must be known before a measured m (as in heart rot) can be translated into r.

Knowing the size of the pole, its strength is calculated by the usual mechanical principles.

Strength Ruler:

To avoid the labor of computation for each radiograph, we have made several calculations and constructed a chart (Fig. 7) with which strengths can be read directly from the film. For poles 16 in. and less in diameter, a simpler ruler may be made by projecting all values to one base line. Some approximations are required in the scale for heart rot, but an over-all accuracy of 95 per cent may be obtained. Auxiliary curves permit corrections to be made for off-center heart rot.

Tests for Accuracy

The final test for any inspection method is its over-all performance after a reasonable length of service. It will be some time before we have sufficient experience upon which to base definite conclusions.

Meanwhile, we have checked the technical accuracy of the X-ray method against such possible errors as misinterpretation of pictures, asymmetry in pole shape, taking radiographs at wrong elevations, and variation of fiber strength from nominal value. Ten rotten poles were tested to destruction after their strengths had been predicted from radiographs. The average breaking load was 14 per cent less than the calculated strength, with individual poles ranging from 5 per cent more to 38 per cent less than calculated. This difference would not be unexpected in a similar test of new poles.

Although this is too small a sample from which to draw conclusions, it covered as wide a range of sizes and rot conditions as was available at the time. We know of no similar tests for condemnations by other inspection procedures. However, incidental to our own tests, it was noted that, although all poles were too weak for the load they had been carrying, only one had been condemned by a recent boring test.

Application to Related Fields

It has been suggested that this method of inspection might be useful in related fields. There are some applications in which the technical problem is practically the same: for example, inspection of new or salvageable

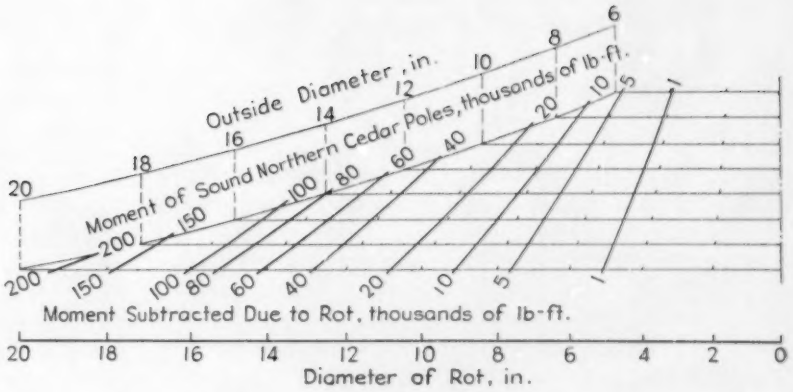

Outside Diameter, in.
Moment of Sound Northern Cedar Poles, thousands of lb-ft.
Moment Subtracted Due to Rot, thousands of lb-ft.
Diameter of Rot, in.

Fig. 7.—Strength Ruler.

Each horizontal axis applies to a pole of a certain outside diameter, as shown on the top scale. Internal measurements may be taken from the inch divisions (short index marks on the axes). Strength of solid pole of each size, and deductions for rot are read similarly. This is a crude scale, for illustration only.

poles and examination of trees to determine age or condition. X-raying new or salvaged poles by radiography or fluoroscopy has been suggested, but no specific means have been proposed for doing the work. Its advisability would depend on whether savings would outweigh the cost. Perhaps X-ray would be justified for special studies—such as rates of penetration under different preservation treatment, or control of routine impregnation. Inspection of trees by X-ray may be warranted, regardless of direct economic balance, when nondestructive tests are desired—for instance, in growth and wound-healing studies, or in deciding whether trees are hazardous.

Another possibility is inspection of structural timber in place, to detect rot. Despite the evident economic attraction, the suitability of X-ray work is questionable, because of difficulty in analyzing the films. Unless it is certain that all wood is dry, or unless pictures can be taken in such directions that the fiber shadows show on the film in the manner described in this paper, there may be grave danger of error in diagnosis. The process would have all the difficulties of metal radiography and several more of its own.

Investigation of marine piling—including study of infestation of samples over long periods—may also be profitably carried on by X-ray. Permanent records without destroying samples may be valuable here. There is naturally a question of whether radiography could be carried on under water, but there are no obvious deterrents—in fact, it may be easier than pole inspecting.

Acknowledgment:

This investigation could not have been carried on without the cooperation of many individuals and organizations. In particular, aside from those in his own company, the author takes this opportunity to express his appreciation of help from individuals in Agfa Ansco, the General Electric X-ray Corp., Harper Hospital, U. S. Rubber Co., and particularly the Westinghouse X-ray Corp. for extensive investigation and use of its equipment in the earlier stages of the work.

DISCUSSION

Mr. Robert Katz.[1]—How do radiographic inspection methods compare with the results achieved in previous inspection methods?

Mr. L. W. Ball.[2]—You have mentioned that rotten wood may be so much wetter than dry wood as to absorb the same amount of X-rays. In this case it is difficult to discover the rot. Is that problem still unsolved?

Mr. Herman E. Seemann.[3]—I should like to ask whether any special attempt was made to reduce secondary radiation?

Mr. H. H. Lester.[4]—What voltage do you use?

Mr. Myron Zucker[5] (*author's closure*).—Mr. Katz asks how the results of radiographic inspection compare with those of other methods. Although we do not have sufficient data to permit a definite answer, we can indicate our method of approach.

As a sample, all untreated poles in two widely separated urban sections were examined by X-ray, after the standard boring-routine inspection by two crews. Radiographs were analyzed, and safety factor computed for each pole. Also, the thickness of good-wood shell was read from the films.

To compare results of the two inspections, points were spotted on the left half side of the accompanying Fig. 1, at the safety factor and minimum shell thickness (determined by X-ray) for each pole *passed* by the borers. The right-hand portion of Fig. 1 was made similarly for poles *condemned* by boring. Since borers are quite attentive to shell thickness, we expect to find over 2 in. good wood on all poles they pass, and less than 2 in. on most of the ones they condemn. This tendency exists. There is also a tendency for passed poles to have higher safety factors than condemned ones.

The disposal of X-rayed poles is based on safety factor. Shaded areas on Fig. 1 show safety factors at which poles are condemned. Since we must be sure that the poles have sufficient strength until next inspection time, the rate of rot enters the picture. There are no data on actual rates; only careful study of X-ray records will produce these figures. The graph shows how violently this unknown

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[4] Senior Physicist, Watertown Arsenal, Watertown, Mass.
[5] Engineering Division, The Detroit Edison Co., Detroit, Mich.

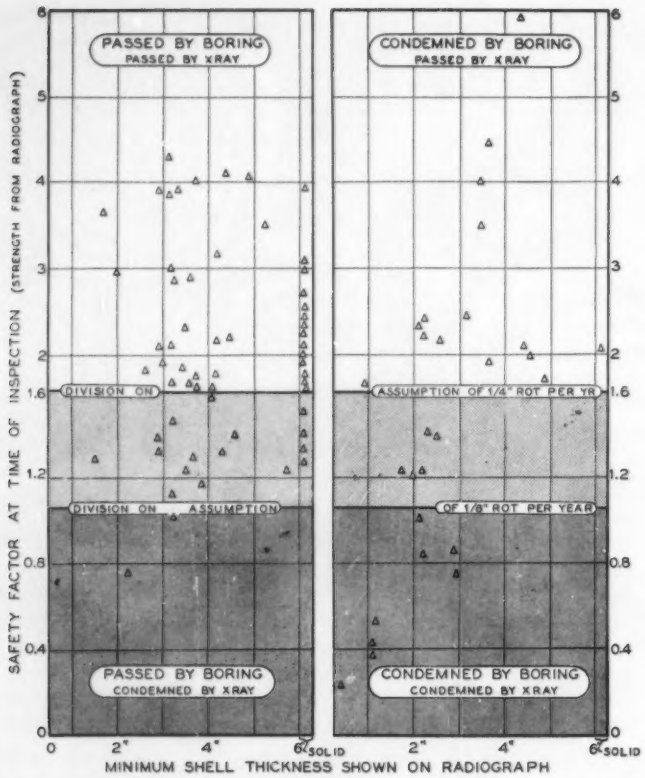

Fig. 1.—Comparison of Condensation of Distribution Poles. Inspected by Boring and X-ray in Detroit.

affects the number of poles condemned. In this particular case, if we assume rot to progress $^1/_8$ in. per year, we find that the borers condemned 20 poles unnecessarily, but left two hazardous ones standing.

Similar graphs, plotted for work done by different crews in various parts of the territory, vary both in over-all appearance and in detail. The cautious and the optimistic natures of inspectors can be seen. Many more such graphs will be needed before any conclusion can be reached as to the relation between boring and X-ray inspection, but it seems that the tangible savings will justify the more expensive method.

The question raised by Mr. Ball of diagnosing wet rot warrants a restatement of the technique of interpreting film. When moisture is apt to be nonuniform, as is usually the case with poles standing in the earth, the prime diagnostic element is the *condition of the growth rings*. This may be supplemented by changes of general tone.

Replying to Mr. Seeman's question, secondary radiation is present but was reduced to acceptable values by restricting the beam to a minimum. Undoubtedly the rubber girth owes part of its success to its shielding action. In early stages of the work, we used wedges near the X-ray source in a manner similar to Mr. Seeman's work described in his current paper,[6] with no noticeable effect on clarity. Since we want to keep our equipment as simple and rugged as possible, we accept what "secondary" we get since it never makes the difference between being able to interpret the picture properly and not being able to do so.

In reply to Mr. Lester, we worked between about 100 kv. p. and 15 kv. p. (the latter obtained by putting a teakettle heater in series with the Diadex supply). Except for large variations in exposure time required, we could find surprisingly little difference. Films were all clear and legible. To expedite field work, we chose the highest voltage available on a portable unit.

[6] Herman E. Seeman, "The Reduction of Secondary Radiation and of Excessive Radiographic Contrast by Filtration," *Proceedings*, Am. Soc. Testing Mats., Vol. 40 (1940).

1941 Meetings in Washington and Chicago

As previously announced, the 1941 A.S.T.M. Spring Meeting and Committee Week will be held in Washington, D. C., at The Mayflower hotel, during the week of March 3 to 7, incl., and the Society's Forty-fourth Annual Meeting and Sixth Exhibit of Testing Apparatus and Related Equipment will be held at The Palmer House in Chicago, June 23 to 27, incl. The Fourth Photographic Exhibit will also be a feature of the Chicago meeting.

While a number of details remain to be decided in connection with the program of the Spring Meeting being held on Wednesday, March 5, in Washington, it is definite that there will be two technical symposiums: one on Color and Its Use in the Testing of Materials; the second on Subsieve Particle Size Measurement. The former will comprise some six technical papers by prominent authors and will include discussion on such topics as introduction to color, color specification of transparent materials, hiding power and opacity, color standards for opaque materials, the spectrophotometer in testing the color of materials, and photoelectric colorimetry. The development of this symposium is in the hands of a special committee headed by M. Rea Paul, National Lead Co., the committee acting for the joint sponsors of the symposium, the Inter-Society Color Council and A.S.T.M. Further details of the symposium will be announced, including authors, personnel of the committees in charge, and the like.

An outline of the Symposium on Subsieve Particle Size Measurement has been developed by C. E. Barnett, New Jersey Zinc Co., chairman of the Section on Pigment-Type Materials of Technical Committee III on Particle Size and Shape of Committee E-1 on Methods of Testing. Six papers and discussions are planned covering the following subjects: gas adsorption, liquid adsorption, centrifugal methods, wave length turbidimetry, permeability, and correlation of particle size measurements.

It is early to make definite announcements on the features of the technical program of the 1941 Annual Meeting, but a symposium on classification of soils is contemplated. Continuation of the discussions on mechanical properties of materials, possibly covering fatigue and fatigue stresses, and a symposium on conditioning are also being considered. There will be the usual large number of technical papers and reports covering various subjects in the field of engineering materials.

Provisional Methods for Testing Sulfur Cements

By P. V. McKinney[1]

For over a century sulfur has been used in various ways as a luting or jointing agent. During this period, and especially through research of the past 20 yr., it has become well established that the addition of suitable aggregate to sulfur will increase the strength of the resulting mixture. The grading of the aggregate as to particle size has been shown to be of value,[2] a fact which had been well established in the case of concrete. In the past many materials have been employed with sulfur cements to impart particular properties which have been desired; for example, iron filings, salt, naphthalene, and other substances have been added. For some uses to which sulfur cements have been applied, however, certain of these materials have proved to be harmful. More recently complex organic compositions have been added to sulfur cements to produce new and specific types of results.

At present sulfur cements are widely utilized in the jointing of cast-iron water mains and clay sewer pipe and in the construction of brick-lined, acid-proof pickling tanks. Cements for application in such widely different fields do not necessarily need to have identical properties. For instance, the cement used in pickling tanks must be completely acid resistant, and hence a silica aggregate, or some similarly acid-resistant material, is required. On the other hand, the sulfur cement for employment in the jointing of cast-iron water mains need not be acid resistant, and, accordingly, another less expensive or more readily available aggregate such as a milled stone, may be used if it is otherwise suitable.

To our knowledge, no organization has published procedures for defining and evaluating sulfur cements, although most city or other governmental bodies which purchase sulfur cements for use in their water systems have set up their own specifications. It is probable that in most cases these governmental requirements are similar and that they have followed the practice used with other structural materials. Looking toward the possibility of having general standards established, this paper is presented to set forth the methods of testing which have been found to be satisfactory in our laboratory. Broadly speaking, these procedures are either identical with or adapted from certain A.S.T.M. specifications for the testing of other structural materials.

Notes on Composition

Sulfur cements are marketed in a variety of forms. Some manufacturers ship bags of a mixture of powdered sulfur and aggregate. Others compound the mixture above the melting point, cast the material, break it, and ship the resulting chunks and fines in bags. In some cases the compounded cement is cast in blocks or pigs and marketed in this form. Mixtures of powdered sulfur and aggregate are subject to segregation during shipment and in solid blocks there may be sections of high sulfur content in the top owing to sedimentation during cooling. It is, therefore, necessary to sample each product by a procedure adapted to its particular physical nature.

The type of aggregate which may be expected in a sulfur cement may vary considerably. The manufacturer will have selected it with respect to the physical properties required for certain uses for which he expects to sell his cement and also with respect to materials available in his neighborhood. Thus commercial sulfur cements may contain silica, feldspar, broken porcelain or pottery, slate, graphite, pyrite, or iron oxide.

Sulfur Content of Sulfur Cement

A 10- to 15-g. sample is sufficient for the determination of sulfur content. The determination may be carried out by means of the glass extractor shown in Fig. 1. An ordinary paper extraction thimble is dried and weighed, the weighed sample is placed in the thimble, and 40 to 50 ml. of carbon disulfide (CS_2) is poured over it. The thimble containing the sample is suspended under the condenser by a fine wire bail, as shown in Fig. 1. The flask is cautiously heated by a steam bath or electric heater, just enough to vaporize the solvent. Cold water is circulated through the condenser. The CS_2 distills from the flask, is condensed, and drops back upon the sample through which it filters, thus dissolving out the sulfur, which collects in the bottom of the flask. The extraction should be carried on until the CS_2 has filled the filter thimble and siphoned over 15 to 20 times. To determine whether the extraction is complete, the filter should be removed and washed with a fine jet of

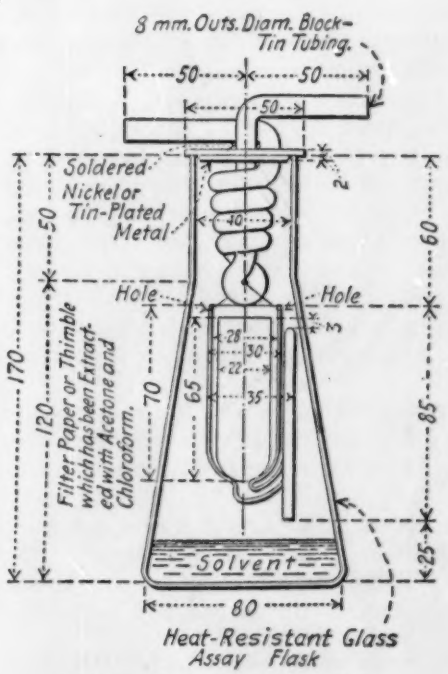

Fig. 1.—Extraction Apparatus.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa.

[1] Senior Industrial Fellow, Mellon Institute, Pittsburgh, Pa.

[2] W. W. Duecker, "Admixtures Improve Properties of Sulphur Cements," *Chemical and Metallurgical Engineering*, Vol. 41, p. 583 (1934).

CS_2 from a washing bottle. The washing should be collected and evaporated to dryness on a steam bath or an electric heater under a hood. If any residue remains, the filter should be put back and extraction continued until the filtrate on evaporation leaves no residue. The filter should then be removed, dried carefully at first at a low temperature to prevent ignition of the absorbed CS_2 and next to constant weight at 110 C. (230 F.) and finally cooled and weighed. Loss of weight represents the sulfur content of the sample. The CS_2 may be distilled from the extracted sulfur and this residue also weighed as a check determination of the sulfur content.

SIEVE ANALYSIS OF AGGREGATE

If a sieve analysis of the aggregate is to be made, the preceding extraction should be conducted on a 200-g. sample so as to obtain sufficient aggregate. The procedure may follow that of the A.S.T.M. Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates (C 136 – 39),[3] or the Tentative Method of Test for Sieve Analysis of Granular Mineral Surfacing for Asphalt Roofing and Shingles (D 451 – 37 T).[3]

MELTING AND CASTING SULFUR CEMENTS

The proper casting of a sulfur cement requires a well-defined technique, and experience has proved that, particularly in the case of structural units, as pickling tanks, the employment of skilled artisans, or at least experienced supervision, is necessary. Sulfur melts readily in the temperature range slightly above the boiling point of water, 120 C. (250 F.), to form a clear, yellow liquid, which has nearly the viscosity of water and therefore pours easily. If either sulfur or sulfur cement is overheated, that is, subjected to temperatures in the neighborhood of 160 C. (320 F.), the mass becomes viscous and even gummy and cannot be poured. But on cooling to the temperature range 120 to 140 C. (250 to 285 F.), the melt becomes fluid again. This overheating will not injure an ordinary sulfur cement, although certain of the new plasticized sulfur cements may be harmed. Consequently, all test specimens should be cast from a melt maintained between 130 and 140 C. (265 and 285 F.).

In order that these specimens may be representative of the original material, the fluid mixture should be stirred thoroughly to prevent the aggregate from settling. Moreover, the time of heating should be short in order to decrease the amount of sulfur lost by vaporization. In particular the melt should not be allowed to become ignited, for of course any loss of sulfur by combustion will change the composition of the mixture. A uniform time and method of mixing of each batch should be definitely selected. A laboratory type mixer operating at 1750 r. p. m., with a propeller-like stirrer of four $^1/_2$-in. fan-type blades and run for 15 min. in the completely melted material, has proved satisfactory in our work. This stirrer should lift the aggregate but must not beat air into the melt.

Where a melted sulfur cement is cast, a pouring gate or some other means must be provided to allow for the shrinkage which occurs on solidification. This technique is similar to the practice in common use with lead and other metals. Sulfur cements may be melted in iron or aluminum vessels, but not in copper or nickel.

The aging of sulfur cements has not been completely investigated, but it is known that the strength increases for some time after casting. Therefore it is essential that a definite age of sample should be used in all tests. In the following "strength" tests all samples are arbitrarily aged two days after casting before being measured. There is considerable variation in individual samples, owing to the variables of cooling, etc., which occur in the process of casting or to an actual lack of precision in the test method and equipment. Therefore a reasonable number of samples should be used to establish each value. During aging the samples are stored at room temperature.

TENDENCY OF AGGREGATES TO SETTLE

The tendency of aggregates to settle out of suspension during solidification or before pouring where the sulfur cement is maintained in molten condition for some time is determined in an 8 by 1-in. glass test tube. The tube is filled with sulfur cement and held at a temperature of 285 F. for 30 min. It is then carefully removed and the contents quickly solidified by immersing the tube in ice water. The test tube is broken, and the top and bottom thirds of the cement are extracted with CS_2 to determine the aggregate content. The numerical ratio of the aggregate content of the bottom of the tube to that of the top is used as an index of the quality of the cement. The numerical factor for a coarse silica aggregate which settles rapidly is greater than unity. The number for a coke aggregate which floats is less than unity. A factor of unity represents a perfect suspension.

VISCOSITY AND POURING QUALITY

The pouring quality of a sulfur cement is affected by the composition of the aggregate and other materials added to the sulfur, and, as a result, the ability of the melt to flow into narrow joints is changed. It has been suggested that this property should be measured by determination of viscosity using a modification of the Engler viscosimeter described by Abraham.[4] The commercial instrument is constructed of copper and brass and should be duplicated in steel or aluminum for use with sulfur cements. The presence of aggregate in the fluid raises some question concerning the employment of the capillary method for this determination. Certainly the size of the capillary must be considered in the case of mixtures containing coarse aggregate.

TENSILE STRENGTH OF SULFUR CEMENTS

The A.S.T.M. Standard Methods of Sampling and Physical Testing of Portland Cement (C 77 – 39)[5] may well be followed in measuring the tensile strength of sulfur cement. The same brass gang molds may be employed, but for use with sulfur cements these molds are placed on smooth plates. Both the molds and plates are wiped with petrolatum or heavy lubricating oil. A short piece of 1 by $^1/_8$-in. strap iron is laid across the narrow part, or neck, of each individual pig in the mold so as to produce a

[3] For both methods, see 1939 Book of A.S.T.M. Standards, Part II, pp. 298, and 1101, respectively.

[4] Herbert Abraham, "Asphalts and Allied Substances," Fourth Edition, p. 811, D. Van Nostrand Co., New York, N. Y.

[5] 1939 Book of A.S.T.M. Standards, Part II, p. 17.

briquet with exactly 1 sq. in. cross-sectional area. A ladle, similar to that commonly used with lead, is used for pouring the sulfur cement. The individual briquets are poured from each end of the pig in order to fill the entire mold as rapidly as possible, and, as the cement sets, the shrinkage depression or pipe is filled. By this procedure a solid briquet is formed having the same dimensions as used in cement testing. During the first few hours after pouring there occurs a transformation of the sulfur crystals from monoclinic to rhombic form. The sulfur cement briquets are allowed arbitrarily to age for two days under normal laboratory conditions, then being broken in the same type of machine as employed in cement testing.

Compression Test Specimens

A gang mold of three 2 by 4-in. cylinders, as referred to in the A.S.T.M. Standard Method of Test for Compressive Strength of Concrete (C 39 – 39),[6] has been modified for use with sulfur cements. One-half-inch holes are drilled into the side of each mold to admit the cement. Smaller holes drilled at each end of the mold allow entrapped air to escape, eliminating air pockets in the specimen. A C-clamp is used to hold two brass plates in position over each end of the gang mold. Both mold and plates are greased before the cement is poured into them. The mold is placed on a side and the sulfur cement is poured through a funnel placed in the $^1/_2$-in. hole. This method was adopted in preference to pouring with the mold upright, because the break obtained in the latter method seemed to be dependent on irregularities in the set in the region of the pouring gate. All specimens are aged in the laboratory for two days before testing.

Flexural Test—Modulus of Rupture and Modulus of Elasticity

For a test of sulfur cement in flexure, bars 1 by 1 by 8-in. are cast in a brass mold. The open sides of the mold are covered with plates held in place with small C-clamps. The mold and plates are greased with petrolatum before the cement is poured in. The mold is placed upright and one of the 1 by 1-in. ends removed and the sulfur cement rapidly poured into the open end, using a ladle in order to fill the mold at one pouring. As the specimen cools, more cement must be added to fill the pipe which forms at the top of the specimen. The bars are allowed to age for two days in the laboratory prior to breaking.

These bars are loaded at the center over a span of 6 in. Deflections of the bar under the load are taken with an indicator dial for every 5-lb. load increment until the specimen fails. The time of loading is observed, so that the rate of loading may be determined. The modulus of rupture is calculated, using the formula

$$S = \frac{3Pl}{2bd^2}$$

where S = stress in pounds per square inch,
P = total load at failure in pounds,
l = span length in inches,
b = width of bar in inches,
d = depth of bar in inches.

From these data it is possible to plot a load-deflection curve from which the slope may be determined and the modulus of elasticity determined by the following formula for those cements which are not plastic. Certain modified sulfur cements are sufficiently plasticized that they do not yield an elastic modulus but are subject to plastic flow.

$$E = \frac{Pl^3}{48DI}$$

where P/D = slope of load-deflection curve in pounds per square inch,
l = span length in inches,
I = section moment of inertia in quadratic inches ($I = bd^3/12$),
E = modulus of elasticity in pounds per square inch.

Contraction of Sulfur Cements on Solidification

We have already pointed out that sulfur cements contract in the process of solidification or setting. This shrinkage is reduced by the presence of aggregate. Simple methods of measuring this change have not proved accurate and therefore a two-step procedure has been devised. The liquid density is first determined on one sample and then the solid density is found on a second sample.

In order to determine the density of the liquid sulfur cement mixture, a deep melting pot is used, the temperature being maintained constant at 140 C. (285 F.) with continuous stirring. Glass culture tubes $^3/_8$ by 3 in., without a lip, are used for measuring a known volume of the liquid mixture. The volume of the sample tube is determined by calibration with pure sulfur having a density of 1.79 at 140 C. In making this calibration, the glass tube is immersed in the liquid sulfur and allowed to reach the liquid temperature, then the full tube is removed carefully to a support and allowed to chill. When cold, any sulfur on the outside is removed and the tube is weighed. The volume of the tube in milliliters at 140 C. is equal to the weight of the sulfur divided by 1.79, its density. If this procedure is repeated for the sulfur cement, the density of the latter is calculated by dividing the weight of the sulfur mixture by the volume in milliliters, or in one calculation by the following formula:

$$\text{Liquid density of cement} = \frac{\text{weight cement}}{\text{weight sulfur}} \times 1.79$$

The density of the solid sulfur cement is determined with the Westphal balance. A small amount of the liquid mixture is poured into a flat dish or tin, and, as it solidifies, a weighed length of wire is placed at one side to serve to hang the specimen from the beam of the balance. If the thickness of this disk of solidified material is kept to less than $^1/_4$ in., all shrinkage cracks should be open to the outside. Ethyl alcohol is used as the immersing liquid in preference to water because the latter is less effective in wetting the sulfur. The calculation is as follows:

$$\text{Density of solid} = \frac{\text{weight solid} \times \text{density alcohol}}{\text{weight solid} - \text{weight in Westphal liquid}}$$

The amount of shrinkage of the liquid sulfur cement on casting is then determined from these data in this way:

$$\text{Percentage of shrinkage} = 100\left(1 - \frac{\text{liquid density of cement}}{\text{solid density of cement}}\right)$$

Determination of Internal Strains

In addition to the shrinkage that occurs as a sulfur cement solidifies, there are further changes as the sulfur cools

[6] 1939 Book of A.S.T.M. Standards, Part II, p. 328.

completely and the monoclinic crystals transform to the stable rhombic state. The following test was devised to indicate roughly the presence of internal strains resulting from such changes. A glass jar or cylinder, 6 in. in diameter, is placed in the center of a shallow aluminum cake pan, about 8 in. in diameter and with straight sides. Both cylinder and pan are lightly greased with oil or petrolatum. Sulfur cement is poured in the annular space to form a shallow ring 1 in. across and $^1/_4$ to $^3/_8$ in. thick. The temperature of the melt and conditions of stirring should be as defined in the directions for melting and casting sulfur cements. The entire ring should be completed in one pouring. Twenty-four hours after pouring the ring is examined for radical cracks.

Resistance to Thermal Shock

A minimum of 15 figure 8 briquets are cast and 12 of them are placed in a wire cage two days after casting. Two large drums of water are provided whose volumes are such that they contain at least 50 to 100 times the total volume of the sulfur cement briquets being tested. One drum is maintained at a temperature of 10 to 15 C. (50 to 59 F.) by chunks of ice; the second drum is heated to 80 to 85 C. (175 to 185 F.). Several bricks are placed in the bottom of the heated drum in order to prevent the wire cage containing the sulfur briquets from becoming overheated by contact with the bottom of the vessel. We have constructed our cage so that the briquets are supported on wire shelves with 1-in. clearance above the briquets and below the next shelf, to insure ready circulation of water. As the test is started, the briquets are placed in the heated bath for 5 min. and then immediately transferred to the cold bath for 5 min.; this cycle is then repeated. After five complete cycles, 3 briquets are removed, marked, and set aside. After each successive five cycles, 3 additional briquets are removed. We thus have sets of 3 briquets each which have received 0, 5, 10, 15, and 20 cycles of temperature reversal. These briquets are next broken in a tension testing machine and their tensile strength is determined.

Moisture Absorption and Chemical Resistance

Sulfur cements are dense, compact materials, and usually determinations of porosity and moisture absorption have not been made. Owing to the nature of the sulfur and the method of casting specimens, they are not easily wet by water and elaborate precautions are necessary in the determination of either porosity or moisture absorption. A detailed study of this problem and of the chemical resistance of sulfur cements has been included in a recent paper by Payne and Duecker.[7] The procedure used for determining water absorption was from the A.S.T.M. Tentative Methods of Test for Apparent Porosity, Water Absorption, Apparent Specific Gravity and Bulk Density of Burned Refractory Products (C 20 – 39 T).[8]

General Discussion of Testing Methods Described

The tests outlined are of course not the only ones that may be applied to sulfur cements. The information presented is intended to cover procedures that will be useful in establishing the most important properties of any individual batch of material. If the character of the aggregate needs to be determined, it may be subjected to chemical analysis. Normally, the determination of silica content (SiO_2) should be sufficient to check the applicability of the cement for use in places where it is exposed to acid solutions. In the newer cements the determination of carbon rather than silica may be necessary, because graphite and coke are being used in cements that are to be in contact with solutions containing hydrofluoric acid. The presence of soluble inorganic salts may be ascertained by extraction of the carbon disulfide residue with water. The calculation may be based either on the loss of weight on extraction or on the weight of the residue obtained by evaporation of the extract.

The presence of organic materials in sulfur cement will not be detected by the tests described here. Most types of organic material which may be expected in sulfur cements will be dissolved by CS_2. If an analysis is desired, the CS_2 extract should be evaporated and the sulfur mixture further extracted at room temperature with a 50 per cent aqueous solution of crystalline sodium sulfide. The residue is then submitted to a combustion analysis for carbon, hydrogen, and sulfur; chlorides may be determined if desired. The general character and amount of the organic compound can be found by such a procedure. Thiokol, naphthalene, sulfur chloride resins, other sulfur resins, and vegetable oils are typical organic materials which may be expected. If the nature of the aggregate residue after the CS_2 extraction indicates that organic material other than carbon is present, it may be further extracted by other organic solvents, and finally carbon is determined in the aggregate residue by combustion.

Occasionally it may be necessary to determine other properties of sulfur cements. The dielectric strength and coefficient of expansion may be measured by standard methods, hardness and abrasion resistance by methods used in testing flooring materials. No satisfactory test has been found for measuring the adhesion of sulfur cement as a jointing compound. A rather complicated method was devised in which a half brick was joined between two whole bricks, using surfaces which would normally be joined in use of the brick. This structure was supported from cradles which permitted application of the pull in a direction perpendicular to the plane of the joints. This procedure worked very well for tests at room temperature but proved cumbersome for work at other temperatures.

In compounding cements, the various physical "strength" measurements have proved very useful in the selection and grading of aggregates. For some particular uses, the results obtained by a determination of the contraction which occurs on solidification may assist in the selection of an aggregate by the manufacturer. For the user of the finished product, this test will aid in determining the size of pouring gate required and the volume of material to be melted, and in other construction problems. The determination of resistance to thermal shock is useful in cement production for the evaluation of materials that are to be subjected to rapid temperature fluctuations.

Acknowledgment:

Acknowledgment is made to W. W. Duecker and C. R. Payne for many helpful suggestions and to W. A. Hamor for his generous encouragement.

[7] C. R. Payne and W. W. Duecker, "Resistance of Sulphur Cements," *Chemical and Metallurgical Engineering*, Vol. 46, p. 766 (1939).

[8] 1939 Book of A.S.T.M. Standards, Part II, p. 963.

Automatic Speed Control for Tension and Compression Testing Machines

By R. K. Bernhard[1]

SHORTENING THE time for testing engineering materials is of practical commercial value for all types of routine investigations. Hence, the question arises how far the speed of testing can be increased without distorting the results. This speed effect will become of special importance when recording stress-strain diagrams of materials with yielding characteristic. Furthermore, the significance of the upper and lower yield point can be solved only by keeping in mind that the yielding represents an unstable dynamic (viscous) stage. Hence, the dynamic qualities, both of specimen and testing machine, enter the picture. In other words, vibration phenomena require a closer control of the velocity of the testing procedure, even for simple, so-called purely "static" investigations. Dynamic properties, such as mass, elasticity,[2] and damping, not only of the material to be tested but also of the machine, including loading, weighing, recording, and control system, have to be taken into consideration.

The purpose of this paper is to discuss means which permit the investigation of these phenomena.[3] More complicated instruments, such as mirror or cathode ray oscillographs, which can scarcely be used in ordinary commercial testing, are excluded.

Dynamic Qualities:

Loading, weighing, recording, and controlling systems, as well as the specimens themselves, represent dynamic units with a certain mass, elasticity, and damping capacity.

Figure 1 (*a*) represents the simplest case, the dynamic substitute for a direct load or weighing system. *One* mass may be assumed as being concentrated in the weight and *one* spring may be substituted for the elasticity of the specimen.

For a lever and poise load or weighing system, the mass of the lever system can be combined with the mass of the poise, the elasticity of the lever system with the specimen. Hence, the dynamic substitute can be assumed as shown in Fig. 1 (*b*).

The dynamic substitute for a hydraulic loading system, however, becomes more complicated (Fig. 1 (*c*)). *Three* masses (machine frame, movable parts, and foundation) are coupled by *two* springs (specimen and hydraulic liquid).

Mass.—The mass does not vary substantially for the different types of testing machines. An exception is a lever and poise weighing or loading system, which possesses a considerably larger effective (reduced) mass due to its inherent indicator magnification. Any mass in the recording or controlling system will obviously distort the results due to inertia effects, especially at higher testing speeds.

Elasticity.[2]—The elasticity, or in other words the spring constant of the systems, varies considerably. In Fig. 2 this variation is represented by means of load deformation characteristics. In all three diagrams the line *AB* shows the load-deformation chart for the specimens and the horizontal projection *AB'* the elastic deformation of the specimen, hence tan α is equal to the spring constant of the specimen.

For the sake of simplicity, let us assume a quasi-static deformation caused by yielding. In other words, the yielding takes place at a slow and constant speed, thus excluding dynamic effects, and is distributed uniformly over the complete specimen. For a direct weight or lever and poise loading device, the line *BC* in Fig. 2 (*a*) is parallel to the base and indicates the plastic deformation of the specimen. Hence, the testing machine might be considered as infinitely soft. In contrast to Fig. 2 (*a*), in Fig. 2 (*b*) an infinitely rigid testing machine is assumed for the sake of theoretical argument and the line *BB'* drops vertically toward the base line. These two cases, therefore, represent the extreme limits. Finally, Fig. 2 (*c*) shows the load deformation characteristic for a screw or hydraulic loading device. The line *CB* (or *C'B*) indicates the load deformation chart of the machine and the horizontal projection *CB'* (or *C'B'*) the elastic deformation of the testing machine[2]; consequently, tan β (or tan β') is equal to the

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa.

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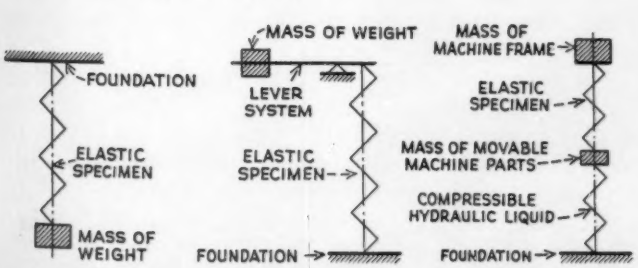
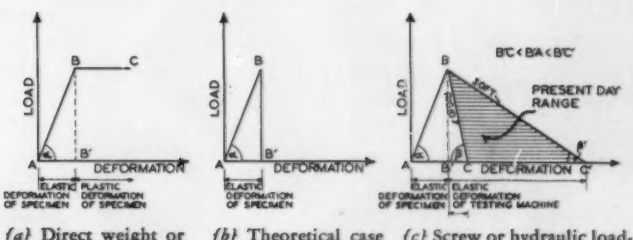
[2] R. K. Bernhard, "Influence of the Elastic Constant of Tension Testing Machines," ASTM BULLETIN, No. 88, October, 1937, p. 14.

[3] Paul G. Jones and H. F. Moore, "An Investigation of the Effect of Rate of Strain on the Results of Tension Tests of Metals," *Proceedings*, Am. Soc. Testing Mats., Vol. 40 (1940).



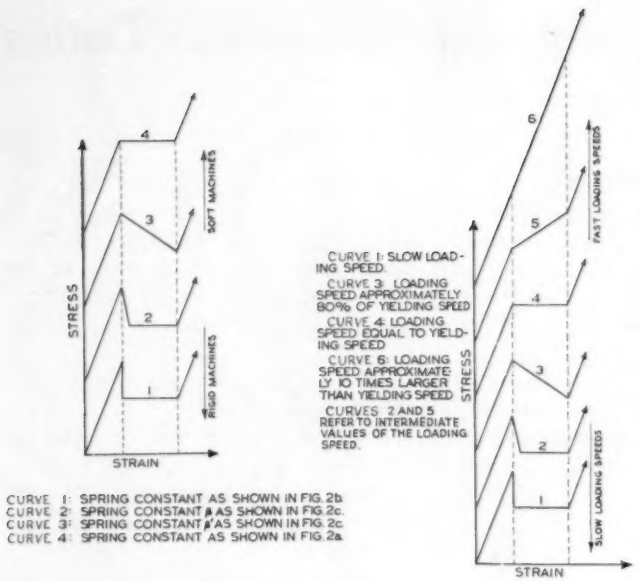
(*a*) Direct loading or weighing system. (*b*) Lever and poise loading or weighing system. (*c*) Hydraulic loading system.

Fig. 1.—Dynamic Substitutes for Testing Machines.



(*a*) Direct weight or lever and poise loading device infinitely soft machine. (*b*) Theoretical case infinitely rigid machine. (*c*) Screw or hydraulic loading device.

Fig. 2.—Load Deformation Characteristics of Testing Machines.


STRESS
STRAIN
SOFT MACHINES
RIGID MACHINES
CURVE 1: SPRING CONSTANT AS SHOWN IN FIG. 2b
CURVE 2: SPRING CONSTANT AS SHOWN IN FIG. 2c.
CURVE 3: SPRING CONSTANT AS SHOWN IN FIG. 2c.
CURVE 4: SPRING CONSTANT AS SHOWN IN FIG. 2a.
CURVE 1: SLOW LOADING SPEED.
CURVE 3: LOADING SPEED APPROXIMATELY 80% OF YIELDING SPEED
CURVE 4: LOADING SPEED EQUAL TO YIELDING SPEED
CURVE 6: LOADING SPEED APPROXIMATELY 10 TIMES LARGER THAN YIELDING SPEED
CURVES 2 AND 5 REFER TO INTERMEDIATE VALUES OF THE LOADING SPEED.
FAST LOADING SPEEDS
SLOW LOADING SPEEDS
(a)
(b)

(a) Material with yielding characteristic recorded on testing machines with varying spring constants. *(b)* Various ratios between loading speed and yielding speed.

Fig. 3.—Stress-Strain Diagrams.

spring constant of the testing machine. The range of our present-day machine lies between C and C', C approaching the more rigid, C' the softer type of machines. The fact that the elastic deformation of a testing machine ($B'C'$) is often larger than the deformation of the test specimen (AB') thus becomes obvious.[3]

Hence, the elasticity of the loading system and the specimen itself varies considerably. The form of the specimens, and for a hydraulic system, the compressibility of the loading system, enters the equation. A long specimen (low elastic constant) will decrease and a short specimen (high elastic constant) will increase the rigidity of the system. Furthermore, in a hydraulic loading system, the position of the piston within the cylinder changes the elasticity. A small volume of oil in the cylinder yields a more rigid unit, a large volume, a more elastic unit.[2] Four-column machines are usually more rigid than two-column machines.

Damping.—The damping is of essential importance for the recording instruments. Especially any friction damping at the recording pen may distort the diagram considerably.

All the above-mentioned dynamic qualities govern the natural frequency of the units. A poise and lever machine has a natural frequency as low as approximately 1 cycle per second. This can easily be verified by exciting the end of the calibrated lever arm by a slight impulse. Hence, the often applied drop-of-beam method will yield other results than those indicated by a hydraulic loading system. The natural frequency of a machine with a hydraulic loading system is much higher. With a small oil volume in the cylinder, this natural frequency might be approximately 600 cycles per second, with a large volume it might decrease to approximately 100 cycles per second. This change in natural frequency due to the varying oil volume during one test has to be kept in mind.

Stress-Strain Diagrams[4]*:*

Spring Constant and Yielding Ranges.—Combining these theoretical considerations as described in Figs. 1 and 2 leads to the form of the stress-strain diagrams (Fig. 3 (*a*)) for various spring constants and for material with yielding characteristics. Curves 1 and 4 represent the theoretical limits, curve 1 for a very rigid, curve 4 for a very soft machine. Curves 2 and 3 indicate the normal diagrams as obtained on our present-day testing machines; the slope between the upper and lower yield point corresponds to the spring constants.

Ratio of Loading Speed to Yielding Speed.[5]—Finally, in Fig. 3 (*b*) the change in form of the stress-strain diagrams due to the ratio of loading speed to yielding speed is shown, hence, assuming different types of materials. With the exception of the additional two upper diagrams, all curves are fundamentally the same as in Fig. 3 (*a*). Curve 1 represents the result on a rigid machine at slow loading speed. The lower yield point is reached by an almost vertical abrupt drop in the stress-strain record. For a loading speed of approximately 80 per cent of the yielding speed (curve 3) the lower yield point is just reached before the increase in stress starts again. If the loading speed is equal to the yielding speed (curve 4) the yielding range shows a horizontal line, and if, finally, the loading speed is approximately 10 times the yielding speed (curve 6) the stress-strain diagram becomes almost a straight line. Curves 4, 5, and 6 indicate no lower yield point, curve 6 almost no upper and certainly no lower yield point.

The present-day machines, where the loading speed is relatively small as compared with the yielding speed, will indicate records similar to curves 2, 3, and 4 (Fig. 3 (*b*)).

It must be clearly understood that Figs. 2 and 3 represent schematic diagrams only, assuming a constant speed of yielding (quasi-static) over the complete area of the specimen, hence neglecting superimposed vibratory phenomena. Furthermore, ideal dynamic instruments would be required to record abrupt changes such as shown in Figs. 2 and 3. Finally, all other speed effects with respect to the yield points, for example, the rise of the yield point at higher testing speeds, are beyond the scope of this paper.

Photocell Control:

Purpose.—A control unit had to be developed which permits a more accurate study of some of these complex questions. Hence, one purpose of this control is to obtain a fully automatic device which allows: (*a*) load holdings, (*b*) constant motion of crosshead for low and high testing speeds, (*c*) constant rate of change of load for low and high testing speeds, and (*d*) constant rate of change of strain for low and high testing speeds.

The control must be adaptable to any type of testing machine. Furthermore, this control has to be economical so as to be useful in commercial testing, and not in special research laboratories, only. Finally, the control must ful-

[4] W. Spaeth, "Physics of Mechanical Testing of Materials" (Physik der mechanischen Werkstoffprüfung), Julius Springer, Berlin (1938).

[5] E. Siebel and A. Pomp, "Yield Phenomena with Respect to Deformation Speed" (Fliessvergang in Abhängigheit von der Verformungsgeschwindigheit), *Mitteilungen* aus dem Kaiser-Wilhelm Institut für Eisenforschung zu Düsseldorf, Vol. 10, p. 83 (1928).

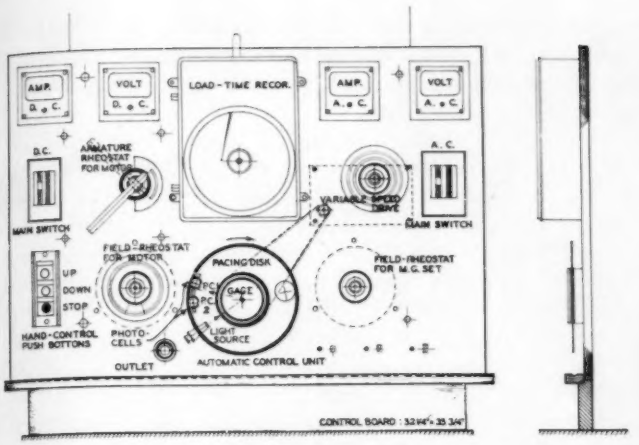
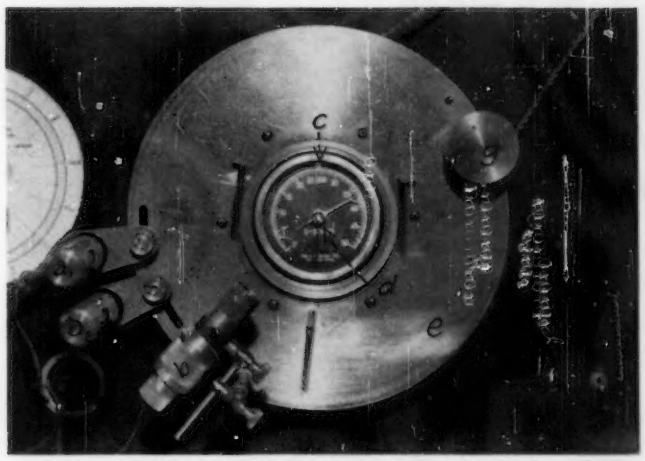


Fig. 4.—Movable Switchboard for Full Automatic Control.



a_1 and a_2 = photocells; b = light source; c = pressure gage; d = reflecting mirror; e = pacing disk; f = drive for pacing disk; g = counterweight.

Fig. 5.—Photocell Arrangement for Full Automatic Control of the Rate of Change of Load.

fill the previously discussed dynamic requirements insofar as possible.

The single members of the control units are selected from commercially available parts. They are mounted on a movable switchboard (Fig. 4) easily transportable to any testing machine in the laboratory. The essential parts represent two photocells[6] which act as inertialess and frictionless relays. Both photocells are mounted on a pacing disk and replace the dots, on the pacing disk, which are now in use, changing the half automatic control into a full automatic control (Fig. 5).

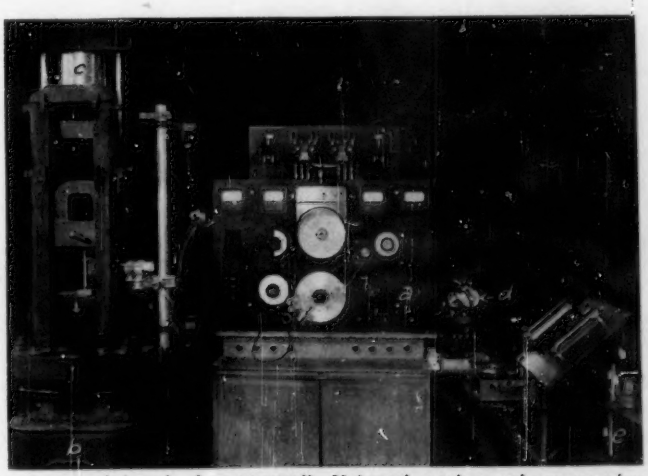
Load-Holding Device.—To hold a predetermined load, a load-indicating instrument, that is, a pressure gage, is connected with a hydraulic capsule and mounted in the center of the pacing disk. A small mirror is fixed rigidly on the central axle of the monometer and reflects a light beam, normally, within the narrow space between the two photocells. Any decrease in load causes a drop in pressure, hence, a rotational motion of the mirror; consequently the light ray energizes the lower photocell. The lower photocell starts the motor of the loading system, the upper photocell reverses the motor. Thus, both cells act as a load-holding device.

Constant Motion of Crosshead.—The pressure gage in the center of the pacing disk is replaced by an ammeter. This ammeter is arranged in the zero branch of a Wheatstone bridge circuit. By means of a resistance wire[7] fixed on the machine base and a sliding contact connected with the crosshead, the ammeter repeats the motion of the crosshead. A small mirror fixed on the central axle of the ammeter reflects a light ray which normally is centered between the two photocells. However, the pacing disk, together with the two photocells, rotates with a predetermined speed corresponding to the required velocity of the crosshead motion. Whenever the lower photocell is energized by the reflected light ray, the driving motor of the loading system is started; when the upper photocell is energized, the motor is reversed. Hence, the crosshead follows the predetermined constant speed of the pacing disk.

Constant Rate of Change of Load.—The instrument in the center of the pacing disk is a pressure gage connected with the capsule of the weighing system as described under Load-Holding Device. Mirror light source and photocells are arranged as before. By means of the two photocells and the rotating pacing disk, the rate of change of load can be controlled.

Constant Rate of Change of Strain.—The instrument in the center of the pacing disk is in this case a dial deflectometer. The motion of the deflectometer represents the deformation of the specimens. This is achieved by using two Selsyn motors, one of which is coupled with a separable extensometer on the specimen, the second motor repeating and transmitting the extensometer motion to the dial deflectometer. Mirror, light source, and photocells are arranged as before.

For special investigations one photocell alone instead of two can be used in such a manner as to accelerate or decelerate the speed of the driving motor; thus the required constant motion of crosshead, constant rate of change of



a = control board; b = 50,000-lb. Universal tension and compression machine (Olsen); c = hydraulic capsule (A. H. Emery, Baldwin Locomotive); d = stress-strain recorder (O. S. Peters, Baldwin Locomotive); e = motor generator set (Ward-Leonard system).

Fig. 6.—Full Automatic Control, Set Up for 50,000-lb. Tension Machine.

[6] See also U. S. Patent No. 2,120,381.

[7] F. Morgenroth, "Electrical Method for Measuring Deflections on Bridges and Bending Vibrations" (Ein elektrisches Verfahren zum Messen von Brücken Durchbiegungen und Biegeschwingungen), *Der Bahningenieur*, Vol. 50/51, No. 37, Berlin (1934).

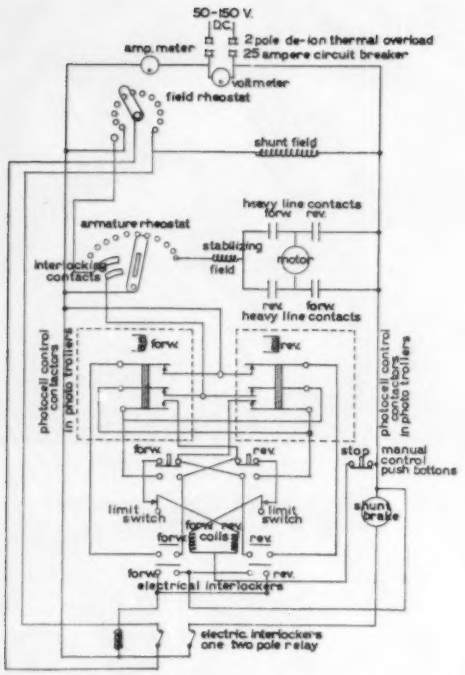


Fig. 7.—Wiring Diagram for Full Automatic Control with Two Photocells.

load or of strain is controlled continuously without necessarily stopping or reversing the motor.

Figure 6 shows the application of this method for a 50,000-lb. Universal Olsen testing machine. The poise and lever weighing system has been supplemented by a hydraulic capsule which is connected with a pressure gage in the center of the pacing disk.

Figure 7 represents the wiring diagram with a two photocell control and with the electric and mechanical interlocking safety devices. In order to obtain the maximum flexibility of the driving motor of the loading system, a direct current motor with mechanical brakes is used. The current is supplied by a motor generator set. The adjustable compound coil in the field (Ward-Leonard system) of the d. c. generator guarantees a constant torque of the d. c. motor at rapid changes in load due to sudden action of the photocell control.

It must be clearly understood that no attempt has been made to change commercially available units in order to fulfill all requirements. The first aim was to obtain a relatively simple and adaptable control unit. Secondly, means to study the above-mentioned effects on stress-strain diagrams of various machines at various testing speeds had to be provided for. Older testing machines could be modernized at relatively low costs. They can, however, be used with or without these control units, that is, for graduate or undergraduate work, respectively.

Acknowledgment:

Special acknowledgment must be made to W. Spaeth for valuable advice, to E. Axman, who designed and built the electric controls, and to S. S. Eckley, who designed and built the pacing disk and drive.

1940 Standards Supplement Scheduled for Publication in November

THE PUBLICATION SCHEDULE calls for the distribution of the 1940 Supplement to the 1939 Book of Standards about November 30. The supplement will be issued in three parts conforming to the 1939 Book of Standards: namely, Part I on Metals, Part II on Nonmetallic Materials—Constructional, and Part III on Nonmetallic Materials—General.

Each part of the supplement will contain the new and revised tentative standards acted upon during the 1940 Annual Meeting and will contain also newly adopted or revised formal standards applying to the respective parts. There will be a section in each supplement devoted to pending revisions of standards.

Preliminary estimates indicate that Part I will have about 101 standards covering some 500 pages; Part II, 88 standards, 350 pages; Part III, 94 standards, 550 pages. These books will be bound in cloth conforming to the binding of the Book of Standards and will also be available in half leather for those who wish to procure this type of binding.

Copies of the supplements will be mailed to the members according to the respective parts of the Book of Standards they received. Extra copies are available for purchase. Full details will be given in a circular which is to be sent to each member early in December.

Important Publications Issued

SEVERAL OF the books and pamphlets which are scheduled for publication during the last quarter of the year have been issued including the Year Book, 1940 Marburg Lecture on Portland Cement, Symposium on New Materials in Transportation, and three of the nine compilations of standards—the ones on petroleum products and lubricants, on cement, and on textile materials.

The symposium comprises the papers and discussion presented at the Spring Meeting in Detroit. It covers various phases, such as exhaust valve materials, automotive steels, rubber, concrete and asphalt, and petroleum products. A special order blank was sent to the members in July. The special price to members is $1.00 in cloth; 75 cents in paper, the list prices being $1.50 and $1.25, respectively.

One of the very significant features of the publication program is the fact that a 1940 edition of each of the nine special compilations of standards is scheduled. Brief descriptions of these books which are steadily coming into wider use were given in the Members' Order Blank, sent late in September. Each of them provides in compact, conveniently usable form all of the A.S.T.M. specifications, tests and definitions, whether standard or tentative, in a particular field. In addition a number of them give much other pertinent information and data—papers and reports, surveys and reference tables.

Discussion on Cement Testing

MESSRS. F. O. ANDEREGG,[1] ROYAL WELLER,[2] AND B. FRIED[3] (by letter).—Messrs. Cloke and Evans in their discussion of "Needed Improvement in the Cement Briquet Testing Apparatus"[4] have joined the investigators who have suggested changing the shape of the briquet specimen for tension testing in favor of a test shape of more rational design. The authors' suggestion that rubber be used as a bearing surface between the specimen and grips is an excellent one, which may prove useful in the testing of brittle materials. The reduction in local stress concentration under the grips is clearly illustrated in the accompanying Figs. 1 and 2. We have felt that a new test shape is essential[5] for tension testing. While the use of rubber grips might have avoided the break in specimens of the type shown in Fig. 1-A of our paper presented before The Society last year,[6] a proper design of the porcelain specimen, Fig. 1-B, achieved the same result.

The fringe photographs of Cloke and Evans are not adequate to permit drawing conclusions. The isochromatic fringes are fuzzy and blurred and in many cases are partially obscured by the isoclinics. The focusing was poor and some of the models had large initial stress (see their Fig. 3). Finally, the fringe orders obtained by them are too low to assure any great accuracy in results, particularly in those cases where large initial stresses were present in the models.

Recently, Fried measured the stress concentration factor for this cement briquet shape and obtained the value 1.79 as an average of ten independent photoelastic measurements.[7] This value is in agreement with that published by Coker and Filon,[8] 1.74, and with the value obtained from the curve plotted in our Fig. 4,[5] 1.78. If the briquet shape is used at all in tension testing, the results of such tests should be multiplied by this correction factor to give a more accurate measure of the breaking strength.

The belief, stated by Cloke and Evans, that by introducing a straight section in the briquet shape (see their Figs. 12 and 13), across which the stress is pure tension, the true tensile strength will be measured, is erroneous. In both the test shapes which they have suggested, the concentration of stresses is such as to indicate the probability of rupture at the fillets. According to our previously published results,[5] the stress concentration factor at the fillets is 1.25. Thus, for tension tests made with shapes proposed by Cloke and Evans, the apparent tensile strength obtained must still be multiplied by the factor 1.25 to give the true tensile strength of the material. While some improvement has been obtained, we respectfully submit that it is not sufficient to warrant adoption of the suggested shape in place of the present one.

As we pointed out,[5] tension specimen shapes should be of such design that the stress concentration factor is as close to unity as is practicable. To effect this, one must use large radii fillets (that is, large with respect to the width of the specimen at the failure section), avoid abrupt breaks in contour, and grip the specimens at points far removed from the failure section.

The statement, "Because of the elastic properties peculiar to portland-cement mortar, the distribution of stress in the cement briquet is even more uniform than is indicated by the bakelite model," is not believed to coincide with general experience in fatigue testing of portland-cement products. As the loading approaches the ultimate, the fatigue effect on the higher stressed portions is greater than on the lower, causing progressive failure. What the authors say is true for sustained strain but not for uniformly increasing stress. In testing brittle materials, therefore, the stress concentration factors are of considerable significance.

MESSRS. PAUL CLOKE[9] AND W. S. EVANS[10] (*authors' closure by letter*).—The discussion of our recent paper on "Needed Improvement in the Cement Briquet Testing Apparatus" by Messrs. Anderegg, Weller, and Fried indicates that the discussors have probably made a more

[1] Consulting Specialist on Building Materials, Newark, Ohio.
[2] Assistant Professor of Civil Engineering, Washington State College, Pullman, Wash.
[3] Engineer, Engineering Experiment Station, Ohio State University, Columbus, Ohio.
[4] Paul Cloke and W. S. Evans, "Needed Improvements in the Cement Briquet Testing Apparatus," ASTM BULLETIN, No. 104, May, 1940, p. 31.
[5] F. O. Anderegg, R. Weller and B. Fried, "Tension Specimen Shape and Apparent Strength," *Proceedings*, Am. Soc. Testing Mats., Vol. 39, p. 1261 (1939).
[6] *Ibid.*, p. 1268.
[7] B. Fried, R. Weller and G. H. Shortley, "Photoelastic Analysis of Stresses in Two- and Three-Dimensional Models," *Bulletin*, Engineering Experiment Station, Ohio State University (in Press).
[8] E. G. Coker and L. N. G. Filon, "A Treatise on Photoelasticity," pp. 578–581, Cambridge University Press (1931).
[9] Dean, College of Technology; Director, Maine Technology Experiment Station; and Professor of Electrical Engineering, University of Maine, Orono, Me.
[10] Professor of Civil Engineering, and Head, Department of Civil Engineering, University of Maine, Orono, Me.

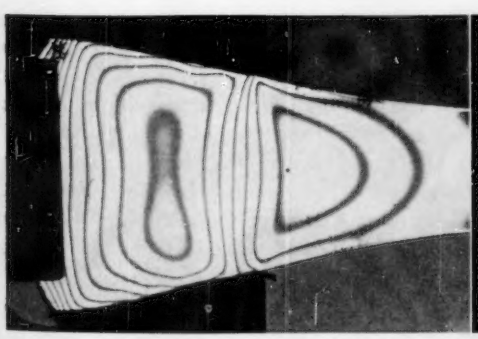


Fig. 1 (left).—Rubber Placed Between Grips and Tension Specimen Practically Eliminated Local Stresses.

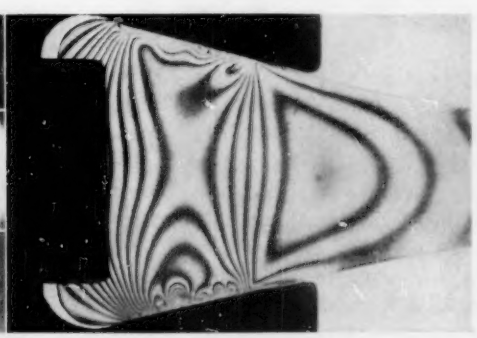


Fig. 2 (right).—Without Rubber Between Grips and Specimen High Local Stress Concentrations Are Apt to Occur.

thorough photoelastic investigation of the stress distribution in a model briquet than had the authors. We should like to point out that the results reported were obtained from the projected image of the model on a screen and not from photographs. Since initial stresses are difficult to control, some small stresses might have been present in the model at the time the studies were made. The photographs were taken long after that and hence are no indication of the conditions of the model at that time.

There are two characteristics which indicate the value of any test, namely, reliability and prognostic value. The former indicates whether the results show anything; the second indicates whether the results give the desired information. If the proposed changes show a worth-while improvement over the present methods in these two respects then regardless of where rupture occurs, it appears to the authors that a change would be worth while. Equipment has been designed and made and tests are now under way to determine the value of the proposed changes as indicated by statistical studies.

LETTER TO THE EDITOR

Subject: Brinell Hardness Testing

(This letter addressed originally to Mr. J. R. Townsend, Chairman of the Section on Indentation Hardness of Committee E-1, is published because the subject is of interest to numerous engineers.)

THE FOLLOWING comments are offered with respect to the Society's Method of Test for Brinell Hardness of Metallic Materials (E 10 – 27):

This laboratory recently had occasion to make some cooperative hardness tests on locomotive driving tires in the approximate range of Brinell hardness number 250 along with the Edgewater Steel Co., manufacturers of the tires. Readings made in our respective laboratories on the same specimens failed to check and it was found after thorough investigation that one of the discrepancies was caused by differences in reading the same Brinell impression in our two laboratories. Differences in Brinell hardness number of approximately 12 were developed in readings made on the same impressions.

We ultimately developed the fact that it is possible in focusing a Brinell microscope to introduce this much error and still have the image of the impression in satisfactory focus for some observers. It had been our practice, and I believe it is the practice in other laboratories, to focus the microscope on the impression and to assume that when the impression is clear and sharp the microscope was properly calibrated. Due, I assume, to different degrees of accommodation of eyesight of various observers this does not always result in a correct measurement of the impression diameter. We have revised our own laboratory procedure to require that the microscope shall be focused on the millimeter test scale furnished with such microscopes and that no refocusing be done when the microscope is transferred from the test scale to the impression whose diameter is being determined.

In discussing this matter with Mr. L. H. Fry of the Edgewater Steel Co., he suggested that it might be worth while to include a note in the Standard Method E 10-27 to emphasize the necessity of focusing and adjusting the microscope on the standard steel or glass scale rather than on the impression. The last sentence in Section 6 (*f*) of the method really covers this but it may be that other laboratories as well as ours may have overlooked the importance of making the adjustment on the scale and that a note emphasizing this necessity would obviate any confusion by other users of Brinell microscopes.

C. B. BRYANT, Engineer of Tests,
Southern Railway System, Alexandria, Va.

LETTER TO THE EDITOR

THE DISCUSSION of various kinds of elastic strength and of the special names given to them still seems to be proceeding vigorously in the A.S.T.M. Inspectors want some kind of elastic strength clearly specified so that they can say "pass" or "fail" to the results of a test. Designing engineers want some value which will indicate the limit below which structural damage by yielding will not occur under given loading conditions on a structural or machine member.

It has come to be pretty generally recognized that there is no absolute value which can be used for all metals and all services as an index of structural damage by yielding. The term "yield point" is perhaps the most satisfactory index of structural damage provided: (1) that the yield point is properly determined (which is by no means always the case), and (2) that the material *has* a yield point. Structural steel and perhaps one or two non-ferrous metals have real yield points, that is, a stress, below the tensile strength, at which strain increases without additional stress. At that stress the stress-strain diagram becomes horizontal or dips downward. The A.S.T.M. Section on Elastic Strength has introduced the term "yield strength" which, by the addition of a numerical factor, can give a definite criterion of elastic strength for any metal, whether or not it has a yield point, and for any use. The numerical value involved will not necessarily be the same for different metals or for different uses of the same metal. This criterion is an "offset" of the stress-strain diagram of Hooke's law so large that it is judged to indicate structural damage. If this offset is shown as 0.1 per cent strain, or greater, it is approximately equal to the permanent set after the release of load. For lower values of offset the permanent set after release of load may be quite different from the "offset." A value of 0.2 per cent has found considerable use in materials specifications. The complete title which should be given to a yield strength should be *n* offset yield strength, in which *n* represents a numerical value of offset which may be considered an index of structural damage by yielding. That is, in several A.S.T.M. specifications, the yield strength might be spoken of as the 0.2 per cent offset yield strength.

Of late years the abbreviation psi. has become quite common for pounds per square inch. It might be found convenient to abbreviate "*n* offset yield strength" to "*n* oys.," that is, in certain specifications of the A.S.T.M. to "0.2 oys."

H. F. MOORE, Professor of Engineering Materials, University of Illinois, Urbana, Ill.

Many New Specifications Issued for Materials of Construction

EACH YEAR when the new list of A.S.T.M. specifications becomes available, there has been included in the October BULLETIN a condensed list of those which are of interest in connection with materials of construction and used in buildings, highways, pipe lines, and other projects. The latest list appearing below should be of interest to a great many engineers, designers, and particularly building code officials and technologists, and others concerned with related phases in these fields. One of the very important essentials in any adequate building code is the provision to insure quality building materials. The widespread reference in building codes to A.S.T.M. standards is significant in this regard.

The standards issued by A.S.T.M. are the result of close cooperation of consumers, producers, and general interests who constitute the makeup of each of the Society's standing committees responsible for standardization activities in a specific field. The decisions made by representatives on these committees are based on the best available data and on a knowledge of production technique, and thus the specifications and tests are considered efficient. The very nature of a committee's organization, affording representation of the major interests concerned, makes the standards unbiased.

Continuing need for recognized standards of quality is evidenced by the intense activities of the various Society committees and the support which the various interests accord this work. Each year new specifications and tests are issued and also many changes are set up in numerous standards to keep them in line with current developments and improved properties as a result of advances in manufacturing practice and technique, and changes in usage or other factors brought about by developments in design, etc. In the list of specifications and tests which follows there are a large number of new items, but there are also included important standards in which revisions of an important nature have been made during 1940.

All of these specifications and tests will be published in their latest approved form in the 1940 Supplement to the Book of Standards and in addition separate copies are made available either before the printing of the Supplements or immediately thereafter.

*Specifications Issued, or Revised in 1940 Covering Various Structural Materials**

METALLIC MATERIALS

Specifications and Tests for:

Welded and Seamless Steel Pipe (A 53 – 40).
Low Tensile Strength Carbon-Steel Plates of Structural Quality for Welding (A 78 – 40).
Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses (A 120 – 40).
Iron and Steel Arc-Welding Electrodes (A 233 – 40 T).
Carbon-Steel Forgings for General Industrial Use (A 235 – 40 T).
Alloy-Steel Forgings for General Industrial Use (A 237 – 40 T).
Naval Brass Rods (B 21 – 40 T).
Bronze Castings for Turntables and Movable Bridges and for Bearing and Expansion Plates of Fixed Bridges (B 22 – 40 T).
Aluminum Sheet and Plate (B 25 – 40 T).
Soft Solder Metal (B 32 – 40 T).
Brass Sheet and Strip (B 36 – 40 T).
Brass Pipe, Standard Sizes (B 43 – 40 T).
Seamless Copper Tubes (B 75 – 40 T).
Aluminum-Alloy (Duralumin) Sheet and Plate (Aluminum-Copper-Magnesium-Manganese) (B 78 – 40 T).
Aluminum-Manganese Alloy Sheet and Plate (B 79 – 40 T).
Aluminum-Alloy (Duralumin) Bars, Rods, Wire, and Shapes (Aluminum-Copper-Magnesium-Manganese) (B 89 – 40 T).
Magnesium-Base Alloy Sheet (B 90 – 40 T).
Copper-Silicon Alloy Plate and Sheet (B 96 – 40 T).
Sheet Copper-Silicon Alloy (B 97 – 40).
Copper-Silicon Alloy Rods, Bars, and Shapes (B 98 – 40).
Magnesium-Base Alloy Bars, Rods, and Shapes (B 107 – 40 T).
Aluminum-Magnesium-Chromium Alloy Sheet and Plate (B 109 – 40 T).
Beryllium-Copper Alloy Bars, Rods, Sheet, Strip, and Wire (B 120 – 40 T).
Copper Rods, Bars, and Shapes (B 133 – 40 T).
Sealing of Anodically Coated Aluminum (B 136 – 40 T).
Weight of Coating on Anodically Coated Aluminum (B 137 – 40 T).

NONMETALLIC MATERIALS

Specifications and Tests for:

Paving Brick (C 7 – 40 T).
Gypsum Plasters (C 28 – 40).
Concrete Aggregates (C 33 – 40).
Gypsum Lath (C 37 – 40).
Gypsum Molding Plaster (C 59 – 40).
Keene's Cement (C 61 – 40).
Building Brick (Made from Clay or Shale) (C 62 – 40 T).
Concrete Sewer Pipe (C 14 – 40 T).
Reinforced Concrete Sewer Pipe (C 75 – 40 T).
Reinforced Concrete Culvert Pipe (C 76 – 40 T).
Portland Cement (C 77 – 40).
Sampling and Physical Testing of Masonry Cement (C 91 – 40).
Refractories for Incinerators (C 106 – 40 T).
Efficiency of Materials for Curing Concrete (C 156 – 40 T).
Volume Change of Cement Mortar and Concrete (C 157 – 40 T).
Sampling Stone, Slag, Gravel, Sand and Stone Block for Use as Highway Materials (D 75 – 40 T).
Woven Cotton Fabrics Saturated with Bituminous Substances for Use in Waterproofing (D 173 – 40 T).
Surveying and Sampling Soils for Highway Subgrades (D 420 – 40 T).
Crushed Stone for Water-Bound Base and Surface Courses (D 489 – 40 T).
Materials for Stabilized Base Course (D 556 – 40 T).
Materials for Stabilized Surface Course (D 557 – 40 T).
Moisture-Density Relations of Soil-Cement Mixtures (D 558 – 40 T).
Wetting-and-Drying Test of Compacted Soil-Cement Mixtures (D 559 – 40 T).
Freezing-and-Thawing Test for Compacted Soil-Cement Mixtures (D 560 – 40 T).
Cut-Back Asphalt (Rapid Curing Type) (D 597 – 40 T).
Cut-Back Asphalt (Medium Curing Type) (D 598 – 40 T).

* Obviously, this list cannot hope to cover all materials coming under the general classification of constructional. There are a number in the field of paints, boiler, and petroleum refinery fields, and others which pertain to materials used in construction. The above list is intended to cover materials used in so-called "general construction."

Inspection by Cement Reference Laboratory

THE CEMENT Reference Laboratory, a joint project of the National Bureau of Standards and the American Society for Testing Materials sponsored by Committee C-1 on Cement, is now preparing for a seventh inspection tour among cement testing laboratories. Those laboratories which desire to avail themselves of this inspection service should promptly address their requests to the Cement Reference Laboratory at the National Bureau of Standards. This proposed tour, in general, will provide only one opportunity for the inspection of any laboratory during the next 2 yr. The work of this next tour will include the verification of compression testing machines which are being used in the testing of cement and are of not more than 100,000 lb. maximum capacity.

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PHILADELPHIA, PENNA.

Research Speaks for Itself

RESEARCH IS one of those words which is virtually impossible to define adequately. As a matter of fact, there have been a great many very interesting definitions, all of which may be *quite* correct depending upon the particular outlook or field of endeavor. From the A.S.T.M. standpoint the phrase from our charter "promotion of knowledge of the materials of engineering" is a broad definition, but even in A.S.T.M. there are a great many different kinds of research going on.

It is not possible to indicate completely the true significance of so many projects, each of which is outlined very briefly in this issue, with references to official sources of information. Only a detailed study of a project will indicate its true significance and that significance may be different for one company than for another.

But one thing is certain: that the vast amount of authoritative information and data which has and is continuing to come from A.S.T.M. sponsored researches is of inestimable value in the engineering fields. Many examples could be cited. To cite a few—the widespread use of copper in steels to improve corrosion-resisting properties is a direct result of the atmospheric corrosion tests sponsored by Committee A-5 and which incidentally are still under way at Annapolis. The very extensive researches in the field of galvanic and electrolytic corrosion under the auspices of the committee on corrosion of nonferrous metals and alloys involving the exposure of thousands of couples have been extremely significant to the communications field, and others. The extensive work on die castings by Committee B-6 on Die-Cast Metals and Alloys was the basis for standardization of specifications for these materials, which requirements were pioneering in this field. The wide researches in cement have affected the methods of evaluating this material. Round-robin tests on electrical insulating materials have resulted in important new specifications and testing procedures. The sampling methods and methods of testing in the field of coal and coke all trace back to researches carried out by Committee D-5.

One could go on with each standing committee of the Society and trace standards, either specifications or test methods, to some research project. Perhaps it was only a brief committee project or it may have been a more extensive one involving years of effort. All of these research projects are worthy of study and every materials engineer should keep in touch with those applicable to his particular field.

The reports describing the tests are readily available and the article in this BULLETIN will give anyone a quick oversight of what A.S.T.M. has under way in his field of research. For convenience an effort has been made to segregate the material under Properties of Materials and Methods of Tests. In some cases, however, the differentiation is difficult.

It is not out purpose to attempt any evaluation of A.S.T.M. research. It speaks for itself.

Knowledge and Wisdom

PARTICIPATING IN a rather interesting discussion on the distinction between knowledge and wisdom which was expressed by one of the participants as intellect and intelligence, we thought of the research work of the Society and its standardization work, for broadly all of it comes under these two heads, either knowledge or wisdom. A.S.T.M. research supplies the knowledge, developing basic authoritative information and data which are digested, perhaps analyzed statistically and made available either through committee reports or technical papers.

Wisdom must now enter the picture (not that wisdom is foreign to research projects but we are thinking of facts and their interpretation). Facts are knowledge; interpretation is wisdom. In a standing committee there must be much wisdom because the facts available must be wisely interpreted and wisely incorporated in any specification or test work worth its salt.

One can be a great intellectual and not be too intelligent; likewise, any company, body, or organization can have a great deal of knowledge and still not be very wise. There cannot be wisdom without knowledge, but there can be knowledge without wisdom. Fortunately, we think we have both in A.S.T.M. committees. The keystone of the arch of standardization rests on wise use and interpretation of basic knowledge of the properties of materials.

Rapid Change

RUBBISH CANS on street curbs waiting to be emptied in the ash handlers' dump truck probably are not expected to start many trains of thought, but the containers that everywhere abound impress one with the intense competition of materials and the very rapid changes that may take place in the use of materials for various services. The number of examples is infinite where a field of use of one material has been invaded by a different material with tremendous industrial implications and drastic changes in the habits and practices of the consumer. In few of these cases has the superseded or partly superseded material given way without a struggle but technologic progress based on sound research inevitably results in change, either in material, procedure, or both.

This is a healthy condition. It stimulates broad thinking and from the standpoint of survival forces organiza-

tions constantly to be on the alert for new uses for their products.

The many relatively rapid changes in the use of materials compel the producer constantly to be on his toes if he is going to continue, but it also should force the consumer to be on the alert because every consumer is in turn a producer, and if he is making sky hooks and a better material becomes available which will make his sky hooks better and possibly cheaper as well to those who use them, he is duty-bound from the service standpoint to take advantage of the new material. Of course all this brings a heavy burden on the materials engineer for he is a vital cog in any large manufacturing organization. On him and his researches and on his *knowledge of other research problems* depends a good deal—the efficiency and ultimate welfare of his organization. This factor imposes on management a direct responsibility to give the materials engineer every reasonable facility that he may keep abreast of progress—or a step ahead of progress.

Actions on 1940 Standards Letter Ballot

A CANVASS on September 3 of the 1940 letter ballot on recommendations affecting A.S.T.M. standards showed that all items listed on the ballot were adopted. The ballot covered the adoption of revisions in 74 standards and the adoption as standard of 39 previously issued tentative specifications, methods, and definitions.

The canvass of the ballot showed that 600 votes had been cast and while the itemized returns will not be published, any member of the Society who desires to know the vote on any particular item can obtain the information from A.S.T.M. Headquarters.

All of the revised standards, as well as all new tentative specifications and tests accepted at the annual meeting and the recent meeting of Committee E-10 (described in this BULLETIN) will appear in the 1940 Supplement to the Book of Standards, the Supplement to be issued about November 15. An article referring to the Book of Standards Supplement appears elsewhere in this BULLETIN.

Sustaining Members Now Total 108

Leading Companies Concerned with Materials, Subscribing

PROBABLY THE most important development in connection with membership work during 1940 has been the large increase in the number of Sustaining Members. On December 31, 1939, there were 29 such members; thus there has been a total of 79 new ones during 1940.

The willingness of these organizations concerned with so many diverse fields to become sustaining members and in this way contribute to the financial support of A.S.T.M. in a manner that can be considered more nearly commensurate with the inherent value of the work to them is significant. It should be kept in mind, too, that many of these companies are contributing in other ways to the A.S.T.M.; namely, through active participation in committee work, through the efforts of the individual members with the companies, and in other ways. The notes which follow give some information along these lines, but they are not intended to be complete.

It has been pointed out that there are very tangible advantages to be derived from sustaining membership. First, each receives a copy of *every* publication issued by the Society, which in addition to regular publications includes all technical books, symposiums, etc., a number of which are available only on purchase. A large number of the sustaining members have used their privilege of obtaining a complete extra set of the Book of Standards. They can also obtain regularly extra copies of the ASTM BULLETIN.

From June 1 to August 28, 1940, the sustaining memberships listed below have been acquired.

New Sustaining Members

AMERICAN CYANAMID CO., R. B. BARNES, RESEARCH LABORATORIES, STAMFORD, CONN.

This organization has been active in the work of the Society for many years, its membership dating from 1927. J. McE. Sanderson, Sales Engineer, New York City, who represented the corporate membership in the Society for some time has recently become a personal member. He serves on Committees D-1 on Paint, Varnish, Lacquer and Related Products and D-17 on Naval Stores and was a member of the New York District Committee. In addition to Mr. Barnes who serves on Committee D-20 on Plastics and is now a member of the New York District Committee, Ladislav Boor, Chemical Engineer, is a member of the Committee D-20 and of Committee D-9 on Electrical Insulating Materials.

CONSOLIDATED GAS ELECTRIC LIGHT AND POWER CO. OF BALTIMORE, H. N. BOETCHER, ASSISTANT TO SUPERINTENDENT, POWER PRODUCTION STATIONS, BALTIMORE, MD.

While this company at the present time is not represented on any committees of the Society, it has been, through memberships held personally by certain of its technical executives, quite active in various phases of standardization and research. A. L. Penniman, Jr., General Superintendent, has been a personal member of the Society since 1931. Both he and Mr. Boetcher have participated actively in the work of the steel committee, particularly on the subcommittee on materials for high temperature service. H. C. Louis, Superintendent, Electric Test, has been affiliated with the Society personally since 1925.

CHAPMAN VALVE MANUFACTURING CO., VINCENT T. MALCOLM, DIRECTOR OF RESEARCH, INDIAN ORCHARD, MASS.

While company affiliation with A.S.T.M. dates with its new sustaining membership, this organization has been represented through a personal membership held by Mr. Malcom since 1921. He is active on several committees, particularly Committee A-1 on Steel, and was the first chairman of A-1's Subcommittee XXII on Materials for High-Temperature Service. At the present time he is a member of this group and other subcommittees. His affiliation on Committees A-3 on Cast Iron and B-3 on Corrosion of Non-Ferrous Metals and Alloys dates from 1922 and 1923, respectively. Mr. Malcolm is one of the original members of Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys. In addition to these activities, he serves on Committee E-7 on Radiographic Testing.

THE PENNSYLVANIA RAILROAD CO., C. D. YOUNG, VICE-PRESIDENT, PHILADELPHIA, PA.

The acquirement of sustaining membership by this company is another

evidence of its active interest in the work of the Society. From the time the A.S.T.M. was organized and its first President was chosen, Dr. Charles B. Dudley, Chief Chemist, Pennsylvania Railroad, Altoona, Pa., this company has been active in A.S.T.M. Many of its engineering and technical executives have been personal members of the Society, participating actively in committee work. For many years Mr. Young, a Past-President (1921–1922), was active in Committee A-1 on Steel, serving as its chairman from 1913 to 1918. F. M. Waring, a personal member, was also chairman of the steel committee and served on various committees. L. B. Jones, Engineer of Tests, Altoona, is extremely active in the work of the steel committee, Committee A-2 on Wrought Iron, and Committee C-1 on Cement. A. R. Wilson, Engineer of Bridges and Buildings, serves on certain A.S.T.M. committees; and M. E. McDonnell, Chief Chemist, who has been a member continuously since 1910, serves on at least eight of the standing committees, his interest being primarily in the field of chemical properties and tests. Recently G. H. Knode, Engineer, became a personal member.

Chrysler Corp., James C. Zeder, Chief Engineer, Engineering Division, Detroit, Mich.

The very active interest of this group in the work of the Society is evidenced not only by its new sustaining membership, but by another company membership, the personal affiliation of several Chrysler engineers and technologists, active participation in committee work, and in other ways. F. M. Zeder, Vice-Chairman of the Board, has been affiliated with the Society since 1917; E. W. Upham, Chief Metallurgist, since 1930; and C. E. Heussner, Materials Engineer, and R. B. Hooper, Chemist, since 1933. Messrs. Upham and Heussner have been especially active in committee work, the former having been a member of Committee D-2 on Petroleum Products and Lubricants since 1930, serving on numerous subcommittees including Technical Committee B on Lubricants where he is a member of several subgroups. Mr. Upham is also active in the work of Committee D-13 on Textile Materials, represents the Society of Automotive Engineers on the Society's Committee B-5 on Copper and Copper Alloys, and has served since 1935 as a member of the Detroit District Committee. Mr. Heussner has contributed important services as a member of Committees B-6 on Die-Cast Metals and Alloys, A-5 on Corrosion of Iron and Steel, B-3 on Corrosion of Non-Ferrous Metals and Alloys, and C-14 on Glass and Glass Products. He has been an active member of the Detroit District Committee for several years. On the Joint Committee on Exposure Tests of Plating on the Non-Ferrous Metals, Mr. Heussner represents the Society. His most recent appointment has been as a member of the Committee on Papers and Publications for a term of 3 yr. F. E. McCleary, Metallurgical Engineer, is a member of Committees A-3 on Cast Iron and E-4 on Metallography. Other technologists of the Chrysler Corp. also serve the Society through committee activities.

Kimble Glass Co., James J. Moran, Technical Manager, Sales Dept., Vineland, N. J.

This organization, a leader in the manufacture of laboratory glassware and related products, has for a number of years had three personal members. Herman K. Kimble, Vice-President and General Manager, has been affiliated since 1923. Mr. Moran and J. F. Greene, Director of Research, have been members since 1933 and 1937, respectively. Mr. Greene represents the company on Committee C-14 on Glass and Glass Products, serving on its subcommittees on chemical analysis and chemical properties. Mr. Moran is very active in the work of Technical Committee XII on Laboratory Glassware of Committee E-1 on Methods of Testing and serves as chairman of Section C on Volumetric Glassware as well as being a member of other sections.

York Ice Machinery Corp., Frank J. Allen, Product Engineer, York, Pa.

Either as a company member or through the affiliation of personal members this company has been continuously represented in the A.S.T.M. since 1905. Their primary interests in committee work have involved the committees on cast iron and on malleable-iron castings on which they have been represented since 1928. J. Bennett has represented the company on these committees since 1931.

Hygrade Sylvania Corp., Arthur L. Chapman, Material Inspector, Emporium, Pa.

Connected with the Society since 1935 through Mr. Chapman's personal membership this company is concerned with various committee activities. At the present time it is represented on Committees E-2 on Spectrographic Analysis and E-3 on Chemical Analysis of Metals. Mr. Chapman has for a number of years represented his company on Committee B-4 on Electrical-Heating, Electrical-Resistance and Electric-Furnace Alloys. He is chairman of this committee's Subcommittee VIII on Metallic Materials for Radio Tubes and Incandescent Lamps and serves on the B-4 Advisory Committee. He is also a consulting member of Subcommittee IX on Mica Products of Committee D-9 on Electrical Insulating Materials.

Rustless Iron and Steel Corp., Henry S. Schaufus, Chief Metallurgist, 3400 E. Chase St., Baltimore, Md.

In addition to its new sustaining membership, the interests of this organization are indicated by individual affiliation on the part of C. E. Tuttle, Chairman and President, who has been associated with the Society since 1932. S. P. Watkins, Manager, Sales Development, is also a personal member. In committee work the company has been chiefly concerned with Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys. At the present time H. S. Schaufus who serves on three of the A-10 subcommittees and A. L. Feild are members. Other technologists of the company serve on Committees E-3 on Chemical Analysis of Metals and E-4 on Metallography.

Montgomery Ward and Co., Gerald C. MacDonald, Director, Ward's Bureau of Standards, 618 W. Chicago Ave., Chicago, Ill.

Since 1937 when this company became a corporate member of the Society they have been represented by Miss Nannene Gowdy, Director, who was very active in the work on textile materials. On Miss Gowdy's retirement this year Mr. MacDonald became the representative of the sustaining membership. Mr. MacDonald serves on the textile committee and its subcommittees on cotton, rayon, wool, and household and garment fabrics. The company's interests in the field of paper and paper products are indicated by its representation on Committee D-6 on Paper and Paper Products, and Subcommittee IV on Fiberboard and Fiberboard Containers, J. N. Hamilton serving.

Union Pacific Railroad Co., William M. Barr, Chief Chemical and Metallurgical Engineer, Omaha, Nebr.

While this organization has been a member of the Society in a corporate capacity since 1919, their sustained interest dates from 1902 from which time until 1921 when Doctor Barr became the company representative, Mr. N. F. Harriman, former Engineer of Tests, was a personal member. Doctor Barr, who before his present term of office as President of the Society, was a Member of the Executive Committee and Vice-President, has for a great many years been active in the work of Committees A-1 on Steel, A-2 on Wrought Iron, and D-1 on Paint, Varnish, Lacquer, and Related Products. Perhaps his outstanding technical service was as chairman of Subcommittee VI on Steel Forgings and Billets of A-1 which he relinquished this year on becoming President. During his chairmanship important carbon-steel and alloy-steel forgings specifications were revised and modernized. R. W. Savidge, Head Chemist, member of A.S.T.M. since 1932, has been for a number of years a member of Committee D-19 on Water for Industrial Uses. Other members affiliated personally with the Society include B. H. Prater, Chief Engineer, and C. R. Pflasterer, Assistant Metallurgical Engineer.

Hercules Powder Co., Emil Ott, Director of Research, Wilmington, Del.

Prior to Mr. Ott's representation of the company, C. E. Kinney, Technical Assistant to Director of Operations, acted for a number of years as representative of the company's membership which dates back to 1921. The company is actively interested in various phases of the Society's work with Mr. Kinney serving as a representative on Committees D-1 on Paint, Varnish, Lacquer, and Related Products and on D-17 on Naval Stores. W. A. Kirklin, Head of Analytical Dept., a

member of the Society for several years, also serves on D-17 and is a member of two of its subcommittees. He also represents the committee on Section XII on Glassware of Committee E-1 on Methods of Testing. The company is represented on other technical committees including D-20 on Plastics.

BARRETT CO., THE, S. P. MILLER, TECHNICAL DIRECTOR, NEW YORK, N. Y.

While the new sustaining membership is the first corporate affiliation of this company with the Society, for many years a number of Barrett technical executives have been extremely active in A.S.T.M. work. The personal membership of C. S. Reeve, Technical Adviser, dates from 1904 and B. A. Anderton, Chemical Engineer, has been an A.S.T.M. member since 1914. F. W. Yeager, Chemist, has been affiliated personally since 1920 and there are other individual members including J. G. Miller. Messrs. Reeve and Anderton have been particularly active in technical committee work, both of them having been for many years concerned with the activities of Committee D-4 on Road and Paving Materials and many of its subcommittees. Among the other committees on which Barrett men have taken a leading part are Committees D-8 on Bituminous Waterproofing and Roofing Materials, D-7 on Timber, D-2 on Petroleum Products and Lubricants, D-11 on Rubber Products, D-1 on Paint, Varnish, Lacquer, and Related Products, and D-18 on Soils for Engineering Purposes. Mr. Reeve, formerly a member of the New York District Committee, served as a member of the Society's Executive Committee from 1936 to 1938.

AMERICAN GAS AND ELECTRIC SERVICE CORP., PHILIP SPORN, VICE-PRESIDENT AND CHIEF ENGINEER, NEW YORK, N. Y.

Mr. Sporn has been concerned with A.S.T.M. work for quite a number of years, his personal membership dating from 1928. He has served since 1936 as a member of Committee A-5 on Corrosion of Iron and Steel and its Subcommittee VI on Specifications for Metallic-Coated Products. In the work on electrical insulating materials, he is a member of Committee D-9's subgroups on electrical tests and on ceramic products and Section C on glass insulators of Subcommittee V.

ACME STEEL CO., RAY F. MAIN, CHIEF METALLURGIST, CHICAGO, ILL.

Mr. Main has been the representative of this company's membership since 1929. During the previous 2 yr., 1927 and 1928, R. H. Norton, President of the company then and now, was the company representative. John E. Ott, Mechanical Engineer, has been an individual member since 1930. He is a member of Committee D-10 on Shipping Containers and also serves as a member of the Chicago District Committee. Mr. Main represents this company on Committees A-1 on Steel and A-5 on Corrosion of Iron and Steel.

Membership to Be Circularized in National Roster of Scientific and Specialized Personnel

IN CONNECTION with the development of the National Roster of Scientific and Specialized Personnel, a joint undertaking of the National Resources Planning Board and the Civil Service Commission, which roster is taking the form of a very extensive card index file, each member of the Society will be asked to fill in one or more questionnaires. One of these, general in nature, gives biographical information, address, age, training, etc., and the other, varying for specific fields, will cover the individual's particular field of practice and technical hobbies. Many of the technical engineering and scientific societies are being included in this extensive undertaking. Many technologists may be asked to fill out several different forms—for instance, a chemical engineer may have filled out the form sent to the members of the American Chemical Society, he may be asked to fill out the one going to A.S.T.M members, etc.

In addition to the work in the field of specialized personnel, it is planned to develop detailed information in the field of testing and research instruments, the number and types of equipment available, and related data. Further details on this phase of the problem will be furnished the members, each of whom will be asked to cooperate.

While the problem of reaching engineers and technologists who are not affiliated with national bodies has not been solved, consideration is being given to this particular phase of the problem.

The roster is under the direct supervision of Dr. Leonard Carmichael, President of Tufts College, and James C. O'Brien of the Civil Service Commission, the latter serving as executive officer. Committees of technical experts will be named as the job goes forward, to evaluate certain lists of names for specific jobs and to protect the continuance of important work in progress in the nation's laboratories.

Dr. John S. Nicholas, Yale University, represents the National Research Council on the National Roster Committee and will serve as Executive Secretary of an Evaluation Committee in the field of engineering. This committee will consist of Acting Chairman Dr. H. A. Poillon, Dr. Maurice Holland, Dr. F. G. Cottrell, Dr. F. M. Feiker, Dr. Webster N. Jones, and Stephen L. Tyler, and the presidents and secretaries of the various technical and engineering societies which are cooperating.

1940 Year Book Mailed

A COPY OF THE 1940 Year Book, recently published, has been mailed to each member of the Society who requested one, an opportunity having been given earlier in the year to members to obtain a copy. Those who did not request one and who have use for it should write A.S.T.M. Headquarters immediately.

This publication, which is furnished only to members, is intended for use in connection with the activities of the Society. It contains a complete membership list, the personnel of the various A.S.T.M. committees and subcommittees, by-laws, regulations governing standing committees, and other material. It also gives the regulations governing papers, committee reports, and discussions, and the recommendations on the form of standards.

In addition to a section on general information about the Society, the Year Book has membership application blanks bound in it, including a student membership blank.

Complete review of current A.S.T.M. research projects appears on pp. 52 to 63, incl.

President Barr Meets with West Coast Members

RECENTLY on a quick trip to the Pacific Coast, President William M. Barr had a luncheon meeting in Los Angeles with a number of members of the Southern California District Committee including John Disario, chairman, E. O. Slater, secretary, and Messrs. R. H. Pierson, R. G. Osborne, H. W. Jewell, F. J. Converse and T. A. Fitch. Doctor Barr has indicated that there was discussion of various A.S.T.M. activities and that a number of suggestions emanated from the meeting which are to be discussed at the next meeting of the Society's Executive Committee. The President's business trip was of such a nature that it was not possible to arrange for a formal meeting of all the members in the district.

Doctor Barr also recently attended a meeting of the members of the Chicago District Committee at which Secretary-Treasurer Warwick was present. This meeting was for the purpose of outlining various activities in connection with the 1941 annual meeting of the Society which is being held at The Palmer House in Chicago, June 23 to 27, incl.

Dudley Medal Committee Appointed

THE COMMITTEE on Award of the Charles B. Dudley Medal has been appointed by the Executive Committee and consists of the following members:

R. W. Crum, *Chairman*, Director, Highway Research Board, National Research Council.

H. S. Rawdon, Chief, Division of Metallurgy, National Bureau of Standards.

T. S. Taylor, Professor in Charge of Research and Graduate Studies, Newark College of Engineering.

This committee will review the eligible technical papers presented at the 1940 Annual Meeting in Atlantic City and select the one of outstanding merit which constitutes an original contribution on research in engineering materials. The award will be made at the Forty-fourth Annual Meeting in Chicago, June 23 to 27, 1941. This Medal was established in 1925 by voluntary subscriptions from members of the Society as a means of stimulating research, recognizing meritorious contributions to the *Proceedings*, and in commemoration of the first President of the Society whose leadership has profoundly influenced A.S.T.M. development.

Schedule of Meetings

DATE	COMMITTEE	PLACE
Oct. 16, 17, 18	D-13 on Textile Materials	New York, N. Y.
Oct. 18	D-6 on Paper and Paper Products	Washington, D. C.
Oct. 30, 31, Nov. 1	B-5 on Copper and Copper Alloys	Washington, D. C.
Nov. 14, 15	D-9 on Electrical Insulating Materials	New York, N. Y.
Dec. 4	D-18 on Soils for Engineering Purposes	Washington, D. C.
March 3–7	Spring Meeting and Committee Meetings	Washington, D. C.
June 23–27	Annual Meeting and Sixth Exhibit of Testing Apparatus and Related Equipment	Chicago, Ill.

1941 Marburg Lecture Committee Appointed

THE COMMITTEE which will select the Edgar Marburg Lecturer for 1941 has been appointed. Under the rules governing the lecture, this group consists of a member of the Executive Committee, a member of Committee E-9 on Research and a member of Committee E-6 on Papers and Publications. The personnel, representing the respective committees in the order named, is as follows: H. H. Morgan, Manager, Rail and Fastenings Dept., Robert W. Hunt Co.; Glen F. Jenks, Colonel, Ordnance Dept., U. S. Army, Office of Chief of Ordnance; and Earl F. Kelley, Chief, Division of Tests, Public Roads Administration, Federal Works Agency.

"Close-Up of Flash Only in Flashover Test at 50 Kilovolts of a 15 Kilovolt Dilecto Oil Switch Bushing"

Second prize winning photograph in the third A.S.T.M. Photographic Exhibit, by N. W. Sieber, Continental Diamond Fibre Co.

Committee on Building Stones and Slates Reorganized

New Subcommittees Set Up and Personnel Listed

GROWING INTEREST in the field of standardization and research as affecting natural building stones and slate and the desire to accelerate the Society's work in this field have resulted in the reorganization of Committee C-18 on Natural Building Stones and Slate. At a meeting held in Atlantic City in June there was discussion by various interests representative of the committee's activities, and in addition to a statement of scope and election of temporary officers, an outline of the committee's future activities was agreed upon and a subcommittee organization was drafted.

The scope of the committee is as follows: The formulation of specifications, methods of test, and definitions pertaining to natural building stones and slate.

A rather extensive program of work has been outlined to cover various phases of the field in which there is definite need as listed below:

1. Establishment of uniform nomenclature applying to the stone industry.
2. Study of prescribed tests and development of standard methods of testing for building stone.
3. Development of quality specifications for building stone: granite, marble, serpentines, limestone, slate, sandstone, and soapstone.
4. Establishment of uniform names and descriptions of finishes for stone.
5. Study of setting methods and anchorage practice.
6. Studies of the effects of various materials and processes used in handling, setting and cleaning, on the appearance and weathering of building stone.
7. Study of the resistance of stone to abrasion under various conditions of usage, and non-slip characteristics of stones for floors.
8. Study of the physical and chemical properties of stone as affecting structural stability and weathering.
9. Study of the effects of external agencies, including working processes, on the appearance and durability of building stone.
10. Study of the thermal properties and fatigue of stone and the effect of various forms of backing.

PERSONNEL

The committee is functioning for the time being with the following temporary officers: W. C. Clark, Engineer Assistant, Public Buildings Administration, Federal Works Agency, as chairman of the committee; T. I. Coe, Technical Secretary, Department of Technical Services, American Institute of Architects, vice-chairman; and D. W. Kessler, Chief, Stone Section, National Bureau of Standards, secretary. The personnel of the committee as listed at present follows:

American Institute of Architects, Department of Technical Services, T. I. Coe.
M. L. Button, J. L. Goss Corp.
Cleveland Quarries Co., Inc., W. M. Jones.
City of Detroit, Department of Buildings and Safety Engineering, C. A. Daymude.
Granite Industry, A. J. Krebs.
R. T. Hamre, Buckingham-Virginia Slate Corp.
Alexander Howie, Alexander Howie, Inc.
Indiana Limestone Institute, J. B. Reinhalter.
D. W. Kessler, National Bureau of Standards.
Lafayette College, W. B. Plank.
T. R. Lawson, Rensselaer Polytechnic Institute.
J. A. McBeath, J. A. McBeath & Sons.
E. H. Nichols, Funkhouser Co.
Public Buildings Administration, W. C. Clark.
C. A. Smith, North Bangor Slate Co.
H. L. Smith, Vermont Marble Co.
Harry Stoddard, Albion Vein Slate Co.
Structural Slate Co., W. A. Kitto.
F. T. Sutton, Vermilya-Brown Co., Inc.
U. S. Bureau of Mines, Oliver Bowles.
U. S. Geological Survey, L. W. Currier.
U. S. Navy, Bureau of Yards and Docks, H. A. Stacy.

As now organized, the committee includes six consumers, six general interests, and ten producers.

SUBCOMMITTEES

In addition to an advisory subcommittee, six other groups have been set up as follows:

Subcommittee II on Nomenclature and Definitions.
Subcommittee III on Test Procedures.
Subcommittee IV on Quality Specifications.
Subcommittee V on Surface Finishes.
Subcommittee VI on Stone Setting and Maintenance.
Subcommittee VII on Cubing.

The work of Subcommittee II will concern the development of uniform nomenclature applying to the stone industry.

As its title indicates, Subcommittee III will be concerned with the development of testing procedures and will in cooperation with Subcommittee II review certain specifications and tests which have already been issued.

Subcommittee IV will be concerned with quality specifications and the group concerned with surface finishes will undertake the preparation of requirements for different types of finishes commonly used in building construction. The group concerned with stone setting and maintenance will make a study of the usual practice followed in setting, pointing, and cleaning stone work in order to determine if the resistance of the different stones to weathering should be recognized in the quality specifications for these materials.

Mr. Kessler is chairman of Subcommittees II and III; Mr. Clark is chairman of Subcommittee IV on Quality Specifications and is also head of the Advisory Group; H. L. Smith heads Subcommittee V on Surface Finishes; and J. A. McBeath, Jr., is in charge of Subcommittees VI and VII.

Complete review of current A.S.T.M. research projects appears on pp. 52 to 63, incl.

Activities of Coordinating Committee on Corrosion

THE SECOND annual meeting of the American Coordinating Committee on Corrosion was held in Atlantic City during the June meeting of the American Society for Testing Materials. The occasion was of particular interest since the Coordinating Committee was initially sponsored by the A.S.T.M. and at this meeting the committee formally moved to relieve the A.S.T.M. of further financial and administrative burden in connection with its own activities. As an alternative, the committee acted to establish a minimum annual operating budget to be prorated among the nineteen member organizations. At this meeting Dr. F. N. Speller, representing the American Chemical Society, was formally named chairman for the year 1940–1941; Dr. R. M. Burns, representing the Electrochemical Society, was named Vice-Chairman, and Dr. G. H. Young, of the Mellon Institute of Industrial Research, Secretary-Treasurer. Committee headquarters are located at the Mellon Institute, 4400 Fifth Ave., Pittsburgh, Pa.

The committee was organized 2 yr. ago to coordinate research activities in this extremely important field, and is patterned after similar organizations abroad. Cooperation has been promised by all the major laboratories actively engaged in corrosion investigations.

As its first contribution, the Coordinating Committee undertook to survey existing corrosion investigations in this country. Information report forms were submitted to some 600 individuals and companies, through the executive offices of the member organizations of the Committee. From the data thus accumulated the Committee issued a confidential Directory of Corrosion Investigators which went out on August first to all persons officially listed in the Directory. Some 325 Directory listings were approved by a Subcommittee on Directory headed by Dr. R. M. Burns. While it is recognized that this first compilation must of necessity be incomplete, it affords an efficient cross index of corrosion researches and researchers. The subject index lists over 215 specific fields of corrosion research from anaerobic bacterial corrosion to zinc coatings.

Although the committee made every effort to see that all competent corrosion investigators were listed, it of course is obvious that a number of omissions occurred from failure to receive the information report blanks.

The committee requests that all corrosion investigators who failed to receive such blanks write Secretary-Treasurer Young so that they can be formally considered for listing in the second issue of the Directory, which will be released early in 1941.

As its second major activity, the committee is sponsoring jointly with Section C of the American Association for the Advancement of Science, a 5-day Symposium on Corrosion to be held sometime during the summer of 1941 (probably about the middle of July) at Gibson Island, Md. Formal announcement and details of the program will be released after the first of the year.

In addition, the committee has extended offers of cooperation to the National Defense Commission and to a number of other Government agencies. In this connection alone, organization of the Coordinating Committee has been extremely timely.

The Committee is at present composed of official delegates from the American Chemical Society, American Electroplaters Society, American Foundryman's Association, American Gas Association, American Institute of Chemical Engineers, American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Heating and Ventilating Engineers, The American Society of Mechanical Engineers, American Society of Refrigerating Engineers, American Society for Metals, American Society for Testing Materials, American Water Works Association, Battelle Memorial Institute, Electrochemical Society, Mellon Institute of Industrial Research, National Bureau of Standards, National District Heating Association, Society of Automotive Engineers, and Technical Association of the Pulp and Paper Industry.

Also elected to membership at the June meeting were the National Research Council, the Chemical Foundation, the Engineering Foundation and the American Welding Society.

Offers of Papers for 1941 Meeting

COMMITTEE E-6 on Papers and Publications in anticipation of developing the program for the 1941 Annual Meeting at The Palmer House, Chicago, June 23 to 27, is desirous that members of the Society and others who have in mind submitting offers of technical papers should send these offers to Society Headquarters well in advance of the February meeting of the committee. All offers must be accompanied by a summary which should make clear the intended scope of the paper and indicate features that in the opinion of the author will justify its inclusion in the annual meeting program. Suitable blanks to be used in transmitting the necessary information will be sent promptly on request.

Book on Corrosion of Iron and Steel

AN IMPORTANT addition to the publications and literature on the subject of corrosion of iron and steel has recently been made through the book by Dr. J. C. Hudson, which is broadly described as a general account of the work of the Corrosion Committee of the British Iron and Steel Institute and the British Iron and Steel Federation. The 320-page publication is not a scientific treatise and does not cover the whole field but is limited to work studied or discussed by the Corrosion Committee of which Doctor Hudson is official investigator. Following a discussion on the economic evil of rust and work of the Corrosion Committee which includes descriptions of the materials and tests, the various chapters cover: significance of rolling scale in rusting process; rusting of unprotected iron and steel in the atmosphere; prevention of rusting by means of paints; protective coatings; rusting when immersed in sea water; rusting of other fields of service; research and laboratory work; researches on corrosion conducted in Great Britain and abroad; what remains to be done in preventing rusting.

The printers, Chapman & Hall, Ltd., 11 Henrietta St., W. C. 2, London, used good judgment in topography, and the illustrations which Doctor Hudson has selected, together with the extensive use of tabular material, add to the value of the publication.

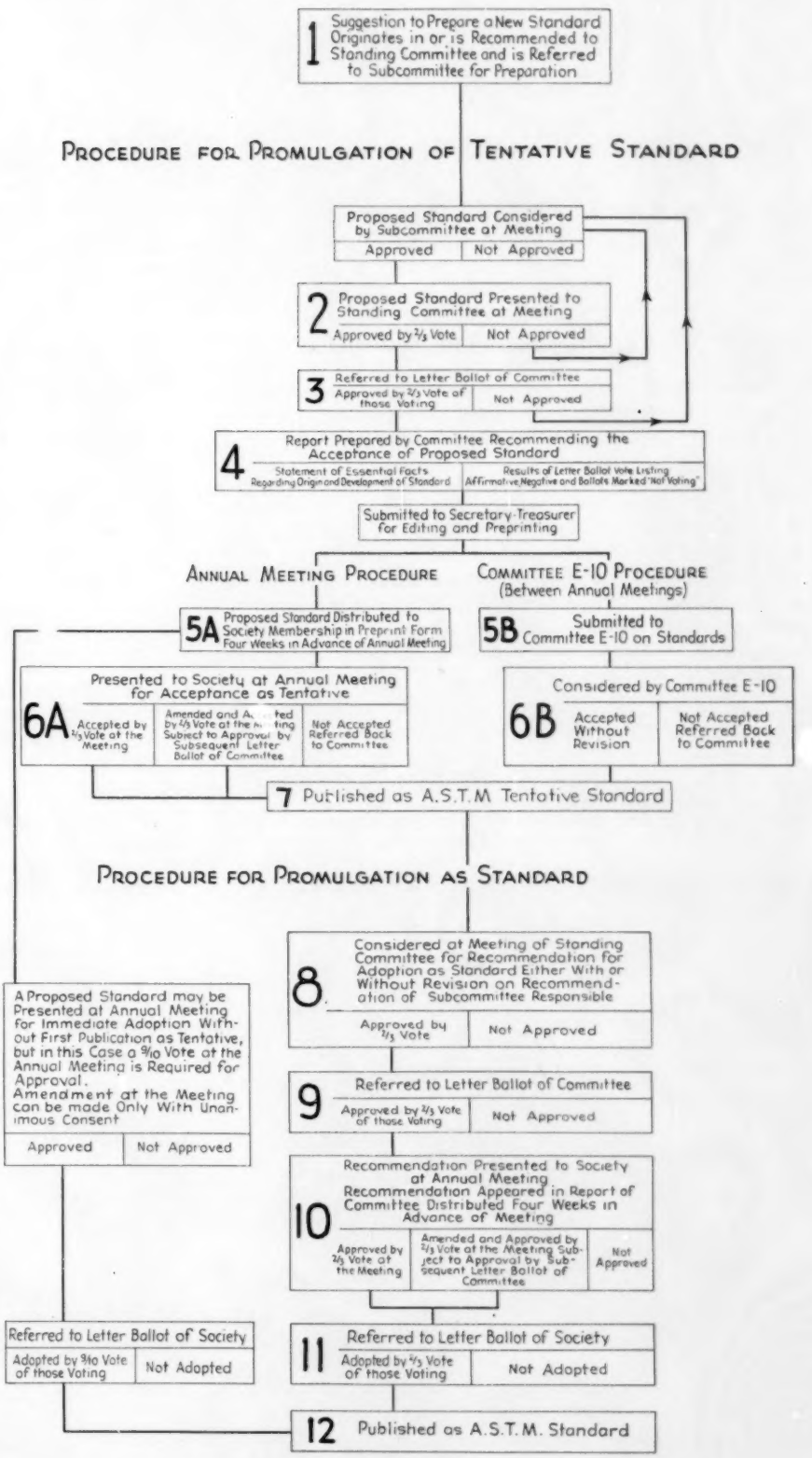
Steps in Standardization

WHILE THE latest flow chart of A.S.T.M. standards procedure may at first glance seem to outline an extremely complicated procedure, closer study by those who are concerned with the development of standards will show that the various steps are not nearly so complex as the chart may seem to make them. It is true that in some phases of the work a number of details have to be carefully watched, but basically the system differs very little from what it was at its inception: namely, that after careful development and approval in a subcommittee, then in a standing committee, the Society as a group must approve the recommendations. In the case of a standard this means approval not only at a meeting, but by formal letter ballot open to the entire membership.

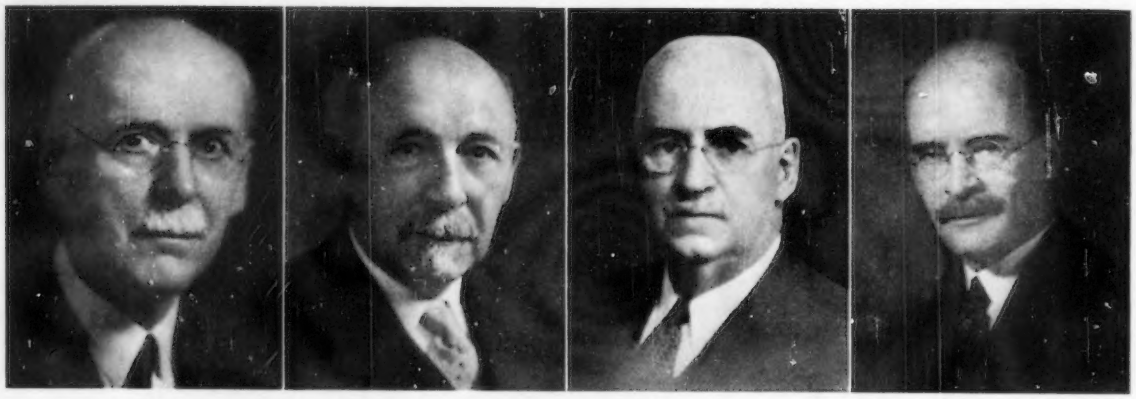
There has been imposed on the basic procedure one important modification: namely, that Committee E-10 on Standards can in the interval between meetings act for the Society in a judicial capacity to determine whether the requirements of the Society relating to committee procedure have been met and whether the committee has reached a satisfactory consensus. But action by Committee E-10 is limited to certain types of actions: It can accept new tentative standards, revisions of tentative standards and tentative revisions of standards.

It can be stated unequivocally that the Society's standardization procedure has been rime tested and that it provides for adequate review by all interests concerned—producers, consumers, and general interests.

It is hoped that this chart will be of service to many of the committee officers and members and to the large number of individuals and organizations who are concerned with the Society's standardization work.


OUTLINE OF STANDARDIZATION PROCEDURE OF THE AMERICAN SOCIETY FOR TESTING MATERIALS
1 Suggestion to Prepare a New Standard Originates in or is Recommended to Standing Committee and is Referred to Subcommittee for Preparation
PROCEDURE FOR PROMULGATION OF TENTATIVE STANDARD
Proposed Standard Considered by Subcommittee at Meeting
Approved
Not Approved
2 Proposed Standard Presented to Standing Committee at Meeting
Approved by 2/3 Vote
Not Approved
3 Referred to Letter Ballot of Committee
Approved by 2/3 Vote of those Voting
Not Approved
4 Report Prepared by Committee Recommending the Acceptance of Proposed Standard
Statement of Essential Facts Regarding Origin and Development of Standard
Results of Letter Ballot Vote Listing Affirmative, Negative and Ballots Marked "Not Voting"
Submitted to Secretary-Treasurer for Editing and Preprinting
ANNUAL MEETING PROCEDURE
COMMITTEE E-10 PROCEDURE (Between Annual Meetings)
5A Proposed Standard Distributed to Society Membership in Preprint Form Four Weeks in Advance of Annual Meeting
5B Submitted to Committee E-10 on Standards
Presented to Society at Annual Meeting for Acceptance as Tentative
6A Accepted by 4/5 Vote at the Meeting
Amended and Approved by 4/5 Vote at the Meeting Subject to Approval by Subsequent Letter Ballot of Committee
Not Accepted Referred Back to Committee
Considered by Committee E-10
6B Accepted Without Revision
Not Accepted Referred Back to Committee
7 Published as A.S.T.M Tentative Standard
PROCEDURE FOR PROMULGATION AS STANDARD
A Proposed Standard may be Presented at Annual Meeting for Immediate Adoption Without First Publication as Tentative, but in this Case a 9/10 Vote at the Annual Meeting is Required for Approval. Amendment at the Meeting can be made Only With Unanimous Consent
Approved
Not Approved
8 Considered at Meeting of Standing Committee for Recommendation for Adoption as Standard Either With or Without Revision on Recommendation of Subcommittee Responsible
Approved by 2/3 Vote
Not Approved
9 Referred to Letter Ballot of Committee
Approved by 2/3 Vote of those Voting
Not Approved
10 Recommendation Presented to Society at Annual Meeting Recommendation Appeared in Report of Committee Distributed Four Weeks in Advance of Meeting
Approved by 2/3 Vote at the Meeting
Amended and Approved by 2/3 Vote at the Meeting Subject to Approval by Subsequent Letter Ballot of Committee
Not Approved
Referred to Letter Ballot of Society
Adopted by 9/10 Vote of those Voting
Not Adopted
11 Referred to Letter Ballot of Society
Adopted by 2/3 Vote of those Voting
Not Adopted
12 Published as A.S.T.M. Standard

Note.–Revisions of a standard follow the same procedure as a new tentative standard



Forty-Year Members—awarded personal member certificates at the 1941 Annual Meeting—from left to right—T. L. Condron, Charles B. Wing, F. H. Clark and Robert Job.

Job Requirements Getting Tougher

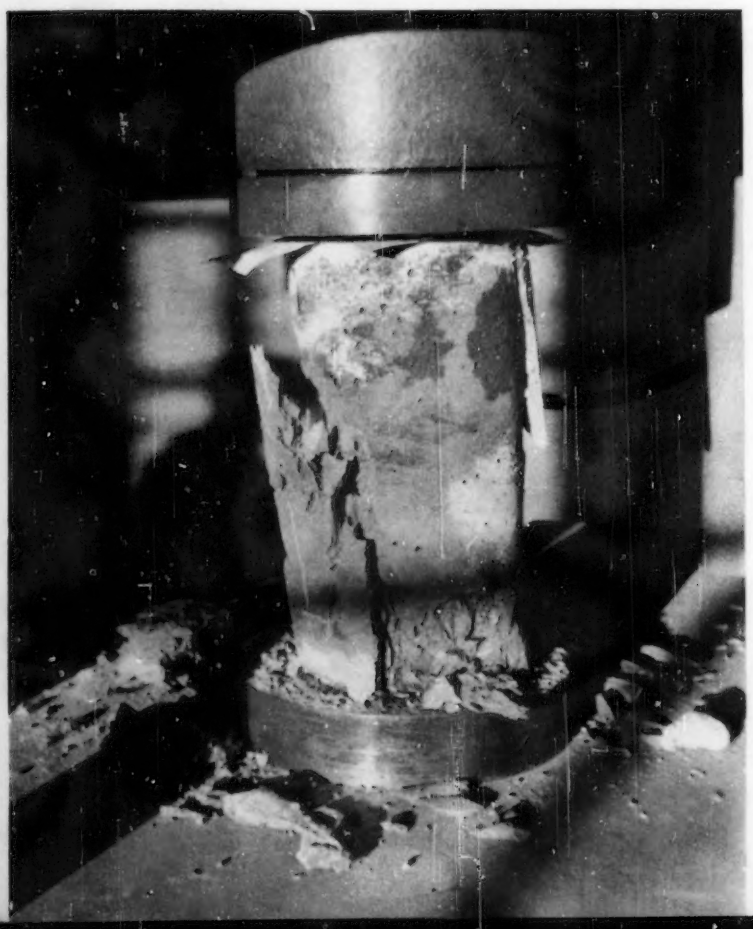
A leading municipality's future refuse collectors must prove themselves of better than average strength by passing a strenuous physical examination as well as a written civil service test according to a recent announcement.

The physical examination inaugurated for 35,000 candidates for refuse collecting jobs will test and grade such abilities as handling an ash can, manipulating 50- to 80-lb. dumbbells, endurance running with weights, jumping a three-foot hurdle, and fence climbing.

Through these physical tests, the department hopes to secure better qualified personnel and to reduce physical injuries in the service to a minimum. Candidates may train for the endurance examination in gymnasiums made available to them without cost by the city's department of parks and the board of education.

"Only the Ultimate"

Awarded honorable mention, amateur class, in the Third A.S.T.M. Photographic Exhibit; submitted by J. I. Berschens, State Highway Commission of Wisconsin.



With apologies to Rudyard Kipling, and the committee on methods of testing.

AIR—"ON THE ROAD TO MANDALAY"

By the Riol-Baldam lying, all as shiny as can be,
There's a row of dog-gone test bars, and I know it's up to me
To test the lot by sundown, and for every pesky one,
Get a yield point that is proper, or there'll be a lot of fun.

There will be a lot of fun,
And when all is said and done,
If I miss the proper yield point,
I am likely to get skun,—

In the lab-o-ra-tor-i-a,
Where the stress-recorders play,
And the boys all try like thunder
To do the things the proper way.

All their gripping-ends are threaded, and they're shiny as can be,
If there's any scratches on 'em, my determinations will not gee
With the theories of the experts, and considerably worse,
All the stuff will be rejected, and the superintendent curse.

And the superintendent curse,—
Bawl me out in accents terse,
If I miss the proper yield point,
There will be a frightful furse,—

In the lab-o-ra-tor-i-a-, etc.

Take me back to nineteen-hundred, when we got our testing done,
When our product was accepted, and a guy could have some fun;
For the good old days are calling, and it's there that I would be,
Pulling tests on that old beamy, getting yields that I could see;

When the beam went down, by gee,
It was plenty plain to see,
That I had a proper yield point,
And I'd better let it be!

In the lab-o-ra-tor-i-a,
When a guy had time for play,
For there weren't no double yield points,
In my lab-o-ra-tor-i-a!

—JOHN HOWE HALL

XXIII. Long-Time Society Committee Members

Twenty-third in the Series of Notes on Long-Time Members

As a continuation of the series of articles in the ASTM BULLETIN comprising notes on the outstanding activities of long-time A.S.T.M. members, there are presented below outlines of the work of three additional members. In general, the men whose activities are described in this series have been affiliated with the Society for 25 years or more and have taken part in committee work for long periods of time. No definite sequence is being followed in these articles.

L. W. Walter F. W. Smither J. E. Myers

J. E. MYERS, Chemist, New York State Department of Public Works, Albany, N. Y., shortly after his graduation from Alfred University, in 1903, from which he subsequently received the degree of Bachelor of Science in 1906, became employed in the Department of the State Engineer in the cement testing laboratory. Three years later he was transferred to the State Highway Department as chemist in charge of the chemical laboratory, and when in 1927 the State Departments of Highways, Canals, Architecture, Engineering and Buildings were consolidated in the State Department of Public Works, he was appointed to his present position. In this capacity he is responsible for the testing of materials used by the department in the construction and maintenance of public works—highways, buildings, and canals.

A member of A.S.T.M. since 1910, he has been active for long periods of time in committee work, especially as a member of Committee D-4 on Road and Paving Materials and D-8 on Bituminous Waterproofing and Roofing Materials. His membership on D-4 dates from 1914 and at the present time he is a member of five of its subcommittees. He has been chairman of its subcommittee on emulsified asphalts for a number of years. After serving a term as vice-chairman, he was this year elected chairman of the main committee and in this capacity acts as chairman of its advisory group.

In Committee D-8, he is active in the subcommittee work on specifications and bituminous emulsions.

There are three other groups in which Mr. Myers is interested actively: the American Association of State Highway Officials, in which organization he is a member of the general committee on materials and of four subcommittees, acting as chairman of two of them on asphalt emulsions and paints; the Highway Research Board—chairman of the committee on marking paints; and is a member of the Association of Highway Officials of the North Atlantic States.

F. W. SMITHER, Chemist, National Bureau of Standards, Washington, D. C., is a graduate of Virginia Polytechnic Institute, 1895, with the degree of B.S. After spending about two years in graduate work at the University of Virginia, and a short time in the laboratories of the Virginia Carolina Chemical Co., and with Dr. Henry Froehling, he was chemist for the Virginia Iron, Coal and Coke Co., and then for about seven years was in charge of commercial laboratories in Nashville and Mt. Pleasant, Tenn. Following a period of over seven years activity as chemist in the Contracts Laboratory, Bureau of Chemistry, U. S. Department of Agriculture, where his duties concerned the examination of various materials in connection with government purchasing operations, he has been since 1914 a member of the staff of the National Bureau of Standards—now chief of the section handling detergents, cement and silicate analysis, analysis of lime products, and a variety of miscellaneous materials. At one time he was in charge of the section on analysis of platinum metals and chemical reagents. Allied to his present work is his activity as chairman of the Federal Specifications Executive Committee's technical committees on detergents and on fire-extinguishing liquids.

From the standpoint of longevity his most notable service in the Society has been as a member of Committee D-1 on Paint, Varnish, Lacquer, and Related Products for the period from 1912, when he first became a member of the Society, until 1932. During most of this period he was chairman of its Subcommittee VIII on Methods of Analysis of Paint Materials. Although a change of duties compelled him to relinquish his activities in this group, they were resumed in other fields, notably, Committee C-7 on Lime, of which he has been a member for over ten years serving on four subcommittees; the technical committee on Stoddard solvent of Committee D-2 on Petroleum Products and Lubricants; Committees D-17 on Naval Stores and D-19 on Water for Industrial Uses. He is rendering particularly helpful service to the Society as vice-chairman of Committee D-12 on Soaps and Other Detergents, a position he has held since the committee was organized in 1936, and he is active in a number of subcommittees. He is chairman of its important Subcommittee II on Specifications. He represents Committee D-19 on Water for Industrial Uses on two technical committees of E-1 on Methods of Testing, namely, VII on Chemical Composition, and XII on Laboratory Apparatus.

In addition to his A.S.T.M. work he is actively interested in a number of other groups including: American Chemical Society, American Association for the Advancement of Science, American Oil Chemists' Society, Chemical Society of Washington, and National Association of Dyers and Cleaners.

L. W. WALTER, Inspecting Engineer, Erie Railroad Co., Jersey City, N. J., has been concerned with the field of cement and concrete for almost the entire period he has spent in industrial activities. Following a period as county surveyor of Dearborn County, in Indiana,

of which state he is a native, and city engineer for the City of Aurora, Ind., he was affiliated with the Baltimore & Ohio Railroad. He joined the Society in 1903 while holding the position of "Cement Inspector" with the B. & O. In 1905 he entered the employ of the Erie Railroad Co., where he established a testing laboratory and where over the period of the last 25 yr. he has been charged with the duty of securing a high standard in quality and appearance of masonry and of directing the enforcement of specifications pertaining thereto.

After service as cement inspector and assistant engineer, he became inspecting engineer, which position he has held up to the present time except for a furlough of about 18 months during 1918 and 1919. During this war period he represented the United States Shipping Board Emergency Fleet Corp. on the construction of their first concrete ship at Brunswick, Ga., looking after the Board's interest in matters related to both shipyard plant and hull construction. His assignment there extended over a period beginning with the preparation of the building ways through the work of hull construction, launching, outfitting and the final trial trip of the vessel.

He has been active in the work of a number of A.S.T.M. committees, his affiliation with Committee D-8 on Bituminous Waterproofing and Roofing Materials dating from 1908. He served a period as vice-chairman and was also acting chairman at one time. An active member of Committee C-9 on Concrete and Concrete Aggregates since 1916, he has served on various subcommittees and he has been affiliated with Committee C-1 on Cement since 1914. He has been a member of the C-1 Advisory Committee since 1925, and served as secretary of the committee since 1936. One of his most recent services to A.S.T.M. was as a member of the special subcommittee in charge of the work leading to the new tentative specifications covering five types of portland cement (C 150 – 40 T).

He is one of the Society representatives on the Sectional Committee on Specifications for Portland Cement, A.S.A. Project: A1. As a member of the American Railway Engineering Association he is active in the work carried on by their Masonry Committee and by their Special Committee on Waterproofing and is one of the representatives of that association on the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete.

He is one of the early pioneers to recognize the importance of mixing water in concrete in its relation to segregation, water gain, and durability and has for many years stressed the importance of maintaining a safe-working consistency of concrete. As a member of the American Concrete Institute he presented a very interesting paper at the February, 1929, meeting of the institute entitled "Thirty Years Field Experience with Concrete." While this paper is of historic interest it brings out the author's experience in dealing with concrete of different consistencies with particular reference to abusive methods of conveying and placing over-wet concrete. A portion of the closing paragraph reflects his optimism:

> With the lessons learned from experiences of the past, aided from time to time by knowledge gained through the ever-increasing amount of research work that is being done, we can expect that this knowledge applied through the high intelligence in the engineering and contracting profession will result in concrete not only better than some of the concrete of the past, but sufficiently good to meet the requirements of the future."

New Members and Officers of District Committees

THE DISTRICT Committees of the Society organized in important industrial centers of the country have their personnel arranged in such a way that approximately one-third of the membership terms expire each year. With this plan of staggering the membership, the President of the Society makes annual appointments. The officers of the District Committees are selected in the even-numbered years so that this year each of the groups acted to elect officers. In the listing which follows are given, first, the names of men appointed by the President to the District Committee and following them the names of the officers of the committee, usually chairman, vice-chairman, and secretary. An asterisk against the name of a membership appointment indicates a *new* appointment and against the name of an officer, a *new* officer. All others are reappointments or re-elections. For the term 1940 through 1943, inclusive, the following appointments have been made:

CHICAGO: C. E. Ambelang, J. F. Calef, J. deN. Macomb, W. A. Straw, E. R. Young, *E. E. Chapman, *C. H. Jackman, *Paul Van Cleef.
Officers: *E. R. Young, *Chairman*, Climax Molybdenum Co.
J. deN. Macomb, *Vice-Chairman*, Inland Steel Co.
C. E. Ambelang, *Secretary*, Public Service Co. of Northern Illinois.

CLEVELAND: J. C. Hodge, F. G. Steinebach, A. J. Tuscany, *L. M. Currie, *W. W. Rose.
Officers: *A. J. Tuscany, *Chairman*, Tuscany, Turner and Associates.
*Arthur W. Carpenter, *Vice-Chairman*, The B. F. Goodrich Co.
*W. W. Rose, *Secretary*, Gray Iron Founders' Society, Inc.

DETROIT: T. A. Boyd, V. M. Darsey, J. W. Kennedy, J. L. McCloud, W. P. Putnam.
Officers: *J. L. McCloud, *Chairman*, Ford Motor Co.
*C. H. Fellows, *Vice-Chairman*, The Detroit Edison Co.
*Martin Castricum, *Secretary*, United States Rubber Co.

NEW YORK: W. H. Bassett, Jr., M. F. Skinker, E. A. Snyder, R. M. Wilhelm, *R. B. Barnes.
Officers: M. P. Davis, *Chairman*, Otis Elevator Co.
E. A. Snyder, *Vice-Chairman*, Socony-Vacuum Oil Co., Inc.
G. O. Hiers, *Secretary*, National Lead Co.

NORTHERN CALIFORNIA: R. E. Davis, H. D. Dewell, Theo. P. Dresser, Jr., Dennistoun Wood.
Officers: F. M. Harris, *Chairman*, Pacific Gas and Electric Co.
Dozier Finley, *Vice-Chairman*, The Paraffine Cos., Inc.
Theo. P. Dresser, Jr., *Secretary*, Abbot A. Hanks, Inc.

PHILADELPHIA: *E. J. Albert, *L. E. Ekholm, *J. W. Harsch, *S. J. Leonard, *R. R. Moore, *J. F. Vogdes.
Officers: *F. G. Tatnall, *Chairman*, Baldwin-Southwark Division, The Baldwin Locomotive Works.
*L. E. Ekholm, *Vice-Chairman*, Alan Wood Steel Co.
R. W. Orr, *Secretary*, RCA Victor Division.

PITTSBURGH: A. R. Ellis, J. S. Gregorius, J. O. Leech, S. M. Phelps, F. N. Speller, *H. A. Ambrose, *J. C. Sprague.
Officers: F. M. Howell, *Chairman*, Aluminum Co. of America.
*J. J. Shuman, *Vice-Chairman*, Jones & Laughlin Steel Corp.
*H. A. Ambrose, *Secretary*, Gulf Research and Development Co.

ST. LOUIS: L. C. Hewitt, L. A. Wagner, *A. A. Bareuther, *F. G. White.
Officers: Hermann von Schrenk, *Chairman*, Consulting Timber Engineer.
E. J. Russell, *Vice-Chairman*, Mauran, Russell & Crowell.
L. A. Wagner, *Secretary*, Missouri Portland Cement Co.

SOUTHERN CALIFORNIA: John Disario, E. O. Slater, *T. A. Fitch, *H. E. Jung, *Raymond C. Osborne, *R. H. Pierson.
Officers: John Disario, *Chairman*, Columbia Steel Co.
E. O. Slater, *Secretary*, Smith-Emery Co.

New Officers of Standing Committees

In the even-numbered years the Society's various standing committees conduct election of officers. As a result of elections held this year a number of new officers have been chosen. While some of the committees' supplementary regulations provide for a regular turnover in chairman or vice-chairman, in most groups there is no limit on the term of office and the officers may serve for quite a number of years. This is quite frequently the case.

Too much credit cannot be given to those who direct the activities of A.S.T.M. committees, for the progress made in the Society's standardization and research work in the field of materials. In both phases the committees take a leading part. The amount of time and effort required of officers in handling committee work (in many cases very extensive), is frequently great and a considerable portion of time expended by officers is devoted to matters which are not directly reflected in the committee's reports, such as studying and making recommendations on various proposals which come to the Society in connection with its work, arranging for meetings, and numerous other details.

The following list gives the names and connections of all newly elected officers of the Society's standing committees. In all cases not listed former officers were honored by re-election.

New A.S.T.M. Committee Officers

COMMITTEE A-1 ON STEEL—*Vice-Chairman*, H. B. Oatley, The Superheater Co., New York, N. Y.

COMMITTEE A-3 ON CAST IRON—*Chairman*, J. W. Bolton, The Lunkenheimer Co., Cincinnati, Ohio; *Vice-Chairman*, J. T. Mackenzie, American Cast Iron Pipe Co., Birmingham, Ala.; *Secretary*, E. R. Young, Climax Molybdenum Co., Chicago, Ill.

COMMITTEE A-7 ON MALLEABLE-IRON CASTINGS—*Chairman*, F. L. Wolf, The Ohio Brass Co., Mansfield, Ohio; *Vice-Chairman*, J. J. Kanter, Crane Co., Chicago, Ill.

COMMITTEE B-3 ON CORROSION OF NON-FERROUS METALS AND ALLOYS—*Chairman*, Sam Tour, Lucius Pitkin, Inc., New York, N. Y.; *Secretary*, A. W. Tracy, The American Brass Co., Waterbury, Conn.

COMMITTEE C-7 ON LIME—*Chairman*, N. C. Rockwood, *Rock Products*, Chicago, Ill.; *Vice-Chairman*, W. C. Voss, Massachusetts Institute of Technology, Cambridge, Mass.; *Vice-Chairman*, W. E. Carson, Riverton Lime and Stone Co., Inc., Riverton, Va.; *Secretary*, W. V. Brumbaugh, National Lime Assn., Washington, D. C.

COMMITTEE C-8 ON REFRACTORIES—*Vice-Chairman*, L. J. Trostel, General Refractories Co. Laboratories, Baltimore, Md.

COMMITTEE C-13 ON CONCRETE PIPE—*Chairman*, T. F. Doll, Standard Oil Co. (Indiana), Whiting, Ind.

COMMITTEE C-16 ON THERMAL INSULATING MATERIALS—*Vice-Chairman*, R. H. Heilman, Mellon Institute of Industrial Research, Pittsburgh, Pa.

COMMITTEE C-18 ON NATURAL BUILDING STONES AND SLATE—*Temporary Chairman*, W. C. Clark, Public Buildings Administration, Federal Works Agency, Washington, D. C.; *Temporary Vice-Chairman*, Theodore I. Coe, *The Octagon*, Washington, D. C.; *Temporary Secretary*, D. W. Kessler, National Bureau of Standards, Washington, D. C.

COMMITTEE D-4 ON ROAD AND PAVING MATERIALS—*Chairman*, J. E. Myers, New York State Department of Public Works, Albany, N. Y.; *First Vice-Chairman*, H. H. Scofield, Cornell University, Ithaca, N. Y.

COMMITTEE D-6 ON PAPER AND PAPER PRODUCTS—*Chairman*, L. S. Reid, Standardization Laboratory, Metropolitan Life Insurance Co., New York, N. Y.; *Secretary*, G. H. Harnden, General Electric Co., Schenectady, N. Y.

COMMITTEE D-18 ON SOILS FOR ENGINEERING PURPOSES—*Chairman*, C. A. Hogentogler, Public Roads Administration, Washington, D. C.; *Vice-Chairman*, W. S. Housel, University of Michigan, Ann Arbor, Mich.

COMMITTEE D-20 ON PLASTICS—*Second Vice-Chairman*, L. M. Currie, National Carbon Co., Inc., Cleveland, Ohio.

COMMITTEE E-7 ON RADIOGRAPHIC TESTING—*Secretary*, R. A. Gezelius, General Steel Castings Co., Eddystone, Pa.

COMMITTEE E-9 ON RESEARCH—*Chairman*, G. F. Jenks, Office of the Chief of Ordnance, War Department, Washington, D. C.

Calendar of Society Meetings

(Arranged in Chronological Order)

American Society of Civil Engineers—Fall Meeting, Hotel Netherlands-Plaza, October 16–18, Cincinnati, Ohio.

American Association of Textile Chemists and Colorists—Twentieth Annual Meeting, Hotel Commodore, October 18 and 19, New York, N. Y.

American Welding Society—Annual Meeting in conjunction with National Metal Exposition, Hotel Cleveland, October 20–25, Cleveland, Ohio.

American Society for Metals—National Metal Congress and Exposition, Hotel Statler, October 21–25, Cleveland, Ohio.

Association of Official Agricultural Chemists—Annual Meeting, Raleigh Hotel, October 28–30, Washington, D. C.

American Petroleum Institute—Twenty-first Annual Meeting, Stevens Hotel, November 11–15, Chicago, Ill.

American Institute of Chemical Engineers—Thirty-third Annual Meeting, December 2–4, New Orleans, La.

American Society of Mechanical Engineers—Sixty-first Annual Meeting, Hotel Astor, December 2–6, New York, N. Y.

American Society of Agricultural Engineers—Fall Meeting, Hotel Stevens, December 2–6, Chicago, Ill.

American Society of Refrigerating Engineers—Thirty-sixth Annual Meeting, Hotel Commodore, December 4–6, New York, N. Y.

Highway Research Board, National Research Council—Twentieth Annual Meeting, National Academy of Sciences, December 4–6, Washington, D. C.

National Chemical Exposition—Stevens Hotel, December 11–15, Chicago, Ill.

American Association for the Advancement of Science—Bellevue-Stratford Hotel, December 27–January 2, Philadelphia, Pa.

Society of Automotive Engineers—Annual Meeting and Engineering Display, Book-Cadillac Hotel, January 6–10, 1941, Detroit, Mich.

American Road Builders' Association—Annual Convention, January 27–30, New York, N. Y.

American Institute of Electrical Engineers—Winter Convention, January 27–31, Philadelphia, Pa.

American Institute of Mining and Metallurgical Engineers—Annual Meeting, February 17–20, New York, N. Y.

American Concrete Institute—Annual Convention, February 18–20, Washington, D. C.

American Society for Testing Materials—Committee Week and Spring Meeting, March 3–7, Washington, D. C.; Annual Meeting, June 23–27, Chicago, Ill.

American Ceramic Society—Forty-third Annual Meeting, March 30–April 5, Baltimore, Md.

NEW MEMBERS TO OCTOBER 1, 1940

The following 52 members were elected from July 16 to October 1, 1940, making the total membership 4342:

Company Members (10)

American Council of Commercial Laboratories, Daniel E. Douty, Secretary, 1415 Park Ave., Hoboken, N. J.

*American Gas and Electric Service Corp., Philip Sporn, Vice-President and Chief Engineer, 30 Church St., New York City.

*Barrett Co., The, S. P. Miller, Technical Director, 40 Rector St., New York City.

Bell Aircraft Corp., R. C. Woods, Physicist, 2050 Elmwood Ave., Buffalo, N. Y.

Brazil Oiticica, Inc., M. E. Marvin, President, 80 Broad St., New York City.

*Chapman Valve Manufacturing Co., The, V. T. Malcolm, Director of Research, 203 Hampshire St., Indian Orchard, Mass.

Cleveland Wire Works, General Electric Co., B. L. Benbow, Manager, 1331 Chardon Road, Euclid, Ohio.

Granite Industry, A. J. Krebs, Division Manager, Munsey Building, Washington, D. C.

Indiana Limestone Inst., J. B. Reinhalter, Director of Promotion, 911 Colorado Building, Washington, D. C.

Schenley Distillers Corp., A. J. Liebmann, Technical Director, 350 Fifth Ave., New York City.

Individual and Other Members (38)

Adams, F. W., Senior Industrial Fellow, Mellon Institute of Industrial Research, Pittsburgh, Pa.

Brown, R. S., Box 229, Mountain Lakes, N. J.

Christner, G. J., Eastern Manager, Insulation Division, Eagle-Picher Sales Co., 420 Lexington Ave., New York City.

Colbeth, I. M., Chemical Director, The Baker Castor Oil Co., New York City. For mail: 25 N. Twenty-first St., East Orange, N. J.

Crawford, C. A., Engineer, Development and Research Division, The International Nickel Co., Inc., New York City. For mail: 27 Dogwood Drive, Summit, N. J.

Cunnick, P. C., Materials Engineer, Rock Island Arsenal, Rock Island, Ill.

Curtiss, L. F., Research Physicist, National Bureau of Standards, Washington, D. C.

Dirección General de Aviación Naval, Ministerio de Marina, Calle Austria 2561, Buenos Aires, Argentina.

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Dobson, J. V., Chief Engineer, Stackpole Carbon Co., St. Marys, Pa. For mail: 212 Bevington Road, Wilkinsburg, Pa.

Dodd, C. M., Head, Department of Ceramic Engineering, Iowa State College, Ames, Iowa.

Edlund, L. L., Engineer of Design, Armour and Co., Chicago, Ill. For mail: 8220 Langley Ave., Chicago, Ill.

Fair, W. F., Jr., Industrial Fellow, Mellon Institute of Industrial Research, Pittsburgh, Pa.

Font, Manuel, General Manager, Puerto Rico Cement Corp., Box 7, Guaynabo, Puerto Rico.

Gray, W. C., The Bailey Co., Amesbury, Mass. For mail: 50 Sparhawk St., Amesbury, Mass.

Hachmeister, G. J., Chief Engineer, Davis Regulator Co., 2541 S. Washtenaw Ave., Chicago, Ill.

Hollady, E. L., Materials Engineer, Office of Chief of Ordnance, Ordnance Dept., War Dept., Washington, D. C.

Horine, Karl, Research Engineer, Commonwealth Edison Co., Chicago, Ill. For mail: 2233 S. Throop St., Chicago, Ill.

Howie, Alexander, President, Alexander Howie, Inc., 261 Constitution Ave., Washington, D. C.

Iwashita, G. K., Assistant Chief Engineer, Stewart-Warner Corp., 1514 Drover St., Indianapolis, Ind.

Kendall, E. H., Materials Engineer, Commonwealth & Southern Corp., 212 W. Michigan Ave., Jackson, Mich.

Kyle, P. E., Assistant Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Llewelyn, K. G., Cost Accountant, Sarco Manufacturing Corp., Fountain Hill, Bethlehem, Pa.

MacPherson, D. R., Industrial Fellow, Mellon Institute of Industrial Research, Pittsburgh, Pa.

Mandel, Eli, Chemical Engineer, In Charge of Chemical Division, Testing Dept., Commonwealth Edison Co., Chicago, Ill. For mail: 2233 S. Throop St., Chicago, Ill.

Mayberry, M. Glenn, Senior Fellow, Mellon Institute of Industrial Research, Pittsburgh, Pa.

McAdam, F. A., Director of Research, Southern States Portland Cement Co., Box 327, Rockmart, Ga.

Moeller, E. A., Assistant Secretary, Moeller Instrument Co., 132d St. and 89th Ave., Richmond Hill, N. Y.

Moulton, R. S., Technical Secretary, National Fire Protection Assn., 60 Batterymarch St., Boston, Mass.

Peterson, E. L., Project Engineer, Public Works Administration, Federal Works Agency, Washington, D. C. For mail: 1504 City Hall, Buffalo, N. Y.

Selmi, L., Chief Metallurgist, Great Lakes Steel Corp., Ecorse, Mich.

Smith, Arthur G., Secretary, Pacific Testing Laboratories, 3215 Western Ave., Seattle, Wash.

Smith, Arthur L., Research Director, North Star Woolen Mill Co., 218 Second Ave. South, Minneapolis, Minn.

Snyder, J. H., Chief Engineer, The Pfaudler Co., 89 East Ave., Rochester, N. Y.

University of Maryland, College of Engineering, S. S. Steinberg, Dean, College Park, Md.

Valyi, E. I., Consulting Metallurgist, Injecta, Ltd., Tenfenthal, Switzerland. For mail: 68 W. Fifty-eighth St., New York City.

Winn, H. F., Lieutenant, U. S. Navy, Bureau of Yards and Docks, Civil Engineer Corps, Naval Station, Key West, Fla.

Junior Members (4)

Hay, J. M., Chemical Engineer, John E. Fast and Co., 3101 N. Pulaski Road, Chicago, Ill.

Kinnear, R. W., 601 N. Sexton St., Rushville, Ind.

Mackay, W. B. F., Flying Officer, Royal Canadian Air Force, Engineering Branch, 820 Wellington Crescent, Winnipeg, Man., Canada.

Prince, R. K., Jr., Engineer (Senior Detailer), Lockheed Aircraft Corp., Burbank, Calif. For mail: 337 N. Isabel St., Glendale, Calif.

*See article on Sustaining Members, p. 39.

PERSONALS

• • • News items concerning the activities of our members will be welcomed for inclusion in this column.

J. B. Neiman, formerly General Manager, Detroit Plant, Federated Metals Division, American Smelting and Refining Co., has been appointed General Manager of Federated Metals Division's aluminum operations throughout the country and will devote his time exclusively to this work.

L. E. Williams is now Manager, Engineering Societies Personnel Service, Inc., Detroit, Mich. He was Plant Manager, Ray Industries, Inc., Oxford, Mich.

J. W. Schmidt, formerly Mechanical Engineer, Leominster Tool Co., Leominster, Mass., is now with the Springfield Armory, Springfield, Mass.

C. S. Reeve is now located in New York City as Technical Adviser for The Barrett Co. He was formerly Manager, Research and Development, The Barrett Co., Edgewater, N. J.

H. G. Oliver, Jr., is connected with the Goetze Gasket and Packing Co., New Brunswick, N. J., as Research Engineer.

H. W. Durham is now located in Asuncion, Paraguay, as Manager of R. W. Hebard and Co.

The following A.S.T.M. members have been nominated for various offices in the American Welding Society for 1940–1941: G. F. Jenks, Colonel, Ordnance Dept., U. S. Army, Washington, for President; David Arnott, Chief Surveyor, American Bureau of Shipping, New York City, for Second Vice-President; O. T. Barnett, Metallurgist, Black, Sivalls & Bryson, Inc., Oklahoma City, Okla., Vice-President of the Southern District; and H. O. Hill, Assistant Chief Engineer, Fabricated Steel Construction, Bethlehem Steel Co., Bethlehem, Pa., as a Director-at-Large.

John Delmonte is now connected with the Plastics Industries Technical Institute, Glendale, Calif., as Technical Director.

J. G. Bennett, formerly Civil Engineer, Madison, Wis., is now at Robert College, Istanbul, Turkey.

L. F. Rader, who was Associate Professor of Civil Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y., has been appointed Professor of Civil Engineering, University of Wisconsin, Madison, Wis.

E. E. Legge, formerly District Director of Research, American Steel and Wire Co., Worcester, Mass., is now Assistant Director of Research, American Steel and Wire Co., Cleveland, Ohio.

R. O. Griffis, formerly Chief Metallurgist, Richard Thomas & Co., Ltd., Ebbw Vale, Monmouthshire, England, is now Research Engineer, Bethlehem Steel Co., Inc., Bethlehem, Pa.

A number of A.S.T.M. members have been nominated for office in the American Concrete Institute, including the following: For Vice-Presidents, R. E. Davis, Professor of Civil Engineering, and Director, Engineering Materials Laboratory, University of California; and M. O. Withey, Professor of Mechanics, University of Wisconsin; for Director, First District, R. W. Carlson, Associate Professor of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Mass.; for Director, Fourth District, Stanton Walker, Director of Engineering, National Sand and Gravel Assn.; for Director, Fifth District, J. W. Kennedy, Engineer, Service Bureau, Huron Portland Cement Co.; for Director, Sixth District, R. F. Blanks, Senior Engineer, U. S. Bureau of Reclamation, Denver; Director-at-Large, R. W. Crum, Director, Highway Research Board, National Research Council, Washington. Messrs. Davis, Walker and Crum are to succeed themselves in office.

H. A. Depew, formerly Research Chemist, American Zinc Sales Co., Columbus, Ohio, is now connected with The Sherwin-Williams Co., Gloucester City, N. J.

Walter Bohnstengel, formerly Assistant Engineer of Tests, is now Engineer of Tests, The Atchison, Topeka & Santa Fé Railway System, Topeka, Kans.

J. W. Harsch, affiliated with Leeds & Northrup Co., Philadelphia, since 1924, as Assistant Chief Engineer beginning in 1928, has been appointed Chief Engineer, succeeding W. R. Schofield, who has been appointed Director of Engineering.

E. S. Ross, formerly Sales and Development Engineer, is now Assistant Manager, Development Division, in Charge of Specialties, Sun Oil Co., Marcus Hook, Pa.

E. L. Roth is now President, Motor Castings Co., Milwaukee, Wis. He was formerly General Manager and Secretary of this company.

T. E. Sheafer, who was Office Engineer, is now Secretary, National Slag Association, Washington, D. C.

H. M. Tompkins, formerly Chemist, is now Head, Works Control Laboratory, National Carbon Co., Inc., Fostoria, Ohio.

D. L. Ogden has been promoted from Director of Metallurgy to General Superintendent of United States Metals Refining Co., Carteret, N. J.

H. W. Van Benschoten is now President, Knoxville Iron Co., Knoxville, Tenn. He was formerly Vice-President and General Manager of this company.

H. G. McCartney, formerly City Engineer, Alexandria, Va., has opened an office as consulting engineer in Alexandria.

Arthur Schroder, Research Chemist, Pure Oil Co., has been appointed Managing Editor of the *Chemical Bulletin*, the monthly publication of the Chicago Section of the American Chemical Society. In addition to his activities in the A.C.S. and other groups, he is also secretary of the Chicago Chemists Club.

NECROLOGY

We announce with regret the death of the following three members and one representative:

M. A. Healey, Metallurgist, Superior Steel Corp., Carnegie, Pa.

R. T. Hutchins, President, Central Clay Products Co., Wilkes-Barre, Pa. Member since 1939.

Emery L. Lasier, Consulting Engineer; and Chief, Materials Section, U. S. Maritime Commission, Washington, D. C. Member since 1912. Mr. Lasier has served the Society in various capacities, particularly in technical committee work. Prior to his affiliation with the U. S. Maritime Commission he represented companies with which he had previously been connected, including the U. S. Testing Co. and the Titanium Alloy Manufacturing Co. on several committees. He had been a member of Committee A-5 on Corrosion of Iron and Steel for some 17 yr. until he resigned in 1938. His membership on Committee B-2 on Non-Ferrous Metals and Alloys dated from 1921. Other groups on which he held membership, including subcommittee appointments, were Committees D-1 on Paint, Varnish, Lacquer, and Related Products, D-11 on Rubber Products, and B-5 on Copper and Copper Alloys, Cast and Wrought. Because of his interests with the U. S. Maritime Commission he became interested in the work of a number of other technical committees in 1938. He was for a number of years a member of the New York District Committee, serving as secretary. He was also a member of the Washington Committee on Arrangements which has charge of the 1941 Spring Meeting. Mr. Lasier was a member of a number of other engineering and industrial societies and groups.

Leroy M. Law, Consulting Asphalt Technologist, St. Louis, Mo. Member since 1912. Mr. Law had been very active in A.S.T.M. committee work, particularly as a member of Committees D-4 on Road and Paving Materials and D-8 on Bituminous Waterproofing and Roofing Materials. For many years he represented the New Orleans Refining Co. and the Shell Petroleum Corp., with which organizations he was affiliated. Later he became a personal member of both groups. In Committee D-4 he was a member of the subcommittee on spot test and chairman of two other subgroups—one on penetration test and the other on asphalt cements. In the work on waterproofing and roofing materials Mr. Law served on the subcommittees on investigation of bituminous grouts and mastics used for waterproofing purposes and on accelerated weathering tests. He was serving a term as a member of the St. Louis District Committee. Mr. Law was also a member of the A.S.A. Sectional Committee on Methods of Testing Road and Paving Materials.

Standardization is not an end in itself, it is fundamentally a contributor to the efficiency of industry. By serving to eliminate nonessentials it paves the way for rapid and economical production. In the present international competition for political and commercial position, a very narrow margin of superiority may be the factor which determines the swing of the balance. We in America are incorporating the principle of standardization into our industrial efforts so that when we are weighed in the national or international balance, we shall not be found wanting.

—From an address by R. E. Zimmerman, Vice-President in Charge of Research and Technology, United States Steel Corp., before the National Association of Purchasing Agents' Twenty-fifth Annual Convention.

Review of Major A.S.T.M. Research Activities

Projects Listed Under (I) Properties of Materials; (II) Methods of Testing

While the October Bulletins for 1938 and 1939 have listed new research projects initiated during those respective years, there has not been a complete listing since 1937 of the large number of research activities being carried out under Society auspices. Because of the importance of this phase of the Society's work and the fact that there have been many new projects, with numerous ones completed, Committee E-9 on Research feels it desirable again to list in concise form pertinent details, with essential references, on all the current active projects. The results of this study, made by the Headquarters Staff, appear in the following pages.

The projects have been subdivided according to materials fields under two broad divisions—Part I, Properties of Materials; and Part II, Methods of Testing. Sometimes it is difficult because of the nature of a project to decide whether it clearly falls in Part I or Part II—*so therefore members and others interested should be sure to review both Parts of the article.*

Importance of Research and Its Relation to Standardization

The importance of research in the Society's work was clearly recognized by the founder members and it is significant that in the statement of the Society's purpose "the promotion of the knowledge of the materials of engineering" precedes "standardization of specifications and methods of testing." Of course research and standardization frequently go hand in hand, but it is clearly recognized in the Society's work and in its committees that specifications of quality can only be satisfactory if based on correct knowledge. As Dr. A. C. Fieldner expressed it during his term as president: "A.S.T.M. standards are competent because they are based on the best commercial practice, on adequate scientific research, and on sound engineering judgment."

In his presidential address presented at the annual meeting of the Society in 1925, F. M. Farmer asked the question, "What is our purpose in promoting knowledge of engineering materials?" and his answer was this: "To increase the efficiency and effectiveness of the materials of engineering." He pointed out that through research the circle of knowledge is widened, while through education and publicity the contents of the circle are made available to a larger proportion of humanity and thus become more useful.

Dr. F. O. Clements, six years later in discussing research in his presidential address, said that "Standardization must always go forward without building fences to prevent developments or block future progress. Standardization must be the servant and not the master. These admonitions are axiomatic ones that might properly grace the walls of our Society Headquarters. The antidote and remedy for such a danger is 'A continual search for new knowledge' or 'Research in the field of materials.'"

Recognition of the importance of research in its relation to standardization, the close cooperation of industry and various branches of the Government in making possible many of the very extensive programs carried out under Society auspices, the painstaking care of those immediately in charge, the careful compilation and publication of the results—all these combined have brought to A.S.T.M. a reputation for leadership in research in engineering materials. This fact, and acknowledgment that the value of the results of A.S.T.M. research projects during almost four decades is well nigh incalculable, are tributes to all those who have cooperated to make the work possible.

Part I—Research on Properties of Materials

Corrosion of Ferrous and Non-Ferrous Metals

Atmospheric Corrosion Tests of Uncoated Sheets (Committee A-5).—Exposure tests begun in 1915 of bare (uncoated) copper and non-copper-bearing steel and iron sheets under atmospheric conditions at Pittsburgh, Pa. (Completed, 1923; *Proc.*, Vol. 23, Part I), Fort Sheridan, Ill. (Completed, 1928; *Proc.*, Vol. 28, Part I), and Annapolis, Md. Results show most rapid rusting in the industrial atmosphere and especially the increased resistance due to copper additions up to at least 0.15 per cent.

Annapolis tests still in progress. Record of failures to date of No. 22 gage sheets reported, see Reprint, 1940 Report of Committee A-5, or *Proc.*, Vol. 40.

Atmospheric Corrosion Tests of Galvanized Sheets (Committee A-5).—Studies begun in 1926 at five test locations, representing various atmospheric conditions, on corrugated sheets both uncoated and galvanized with various weights of zinc coatings. For report of failures of all galvanized sheets after 7-yr. exposure at Altoona, Pa., and of progress at other sites (*Proc.*, Vol. 34, Part I). Failure of all sheets after $8\frac{1}{2}$-yr. exposure at Brunot Island, Pittsburgh, Pa. (*Proc.*, Vol. 35, Part I). Brief report on correlation of results of Brunot Island tests on sheets, hardware, and structural shapes and electroplated coatings on steel (*Proc.*, Vol. 36, Part I). Initial failures at State College observed; behavior of coated sheets at five test locations described; comparison made of relative severity of five locations on coated and uncoated sheets (*Proc.*, Vol. 38, Part I). Current report records coating failures at Sandy Hook and State College; behavior of coatings at Key West described; ten uncoated sheets exposed at five test locations to show contribution of coatings to life of sheets; data on time elapsing between exposure and perforation reported. Tests to determine seasonal variations, if any, started at Sandy Hook. (Reprint, 1940 Report of Committe A-5, or *Proc.*, Vol. 40.)

Atmospheric Corrosion Tests of Metallic-Coated Hardware, Structural Shapes, Tubular Goods, etc. (Committee A-5).—Studies begun in 1928 at five test locations, representing various atmospheric conditions, on metal products coated with the following eight types of coatings by commercial operations: Hot-dipped zinc, electrodeposited zinc, sherardized (zinc) applied in gas-heated drum, sherardized (zinc) applied in electrically heated drum, electrodeposited cadmium, hot-dipped aluminum, hot-dipped lead (Amaloy), parkerized. Results reported of inspections of the specimens at all test locations after 2-, 4-, and 6-yr. exposures, respectively (*Proc.*, Vols. 31, 33, 35, Part I).

In the material which follows, reference is made in almost every case to the latest report on each project. In numerous cases, 1940 preprinted reports are referred to with a reference also being given to the 1940 *Proceedings* of the Society where the reports will be finally published. Certain abbreviated forms are used, for example, *Proceedings*, Vol. 39 (1939) are abbreviated "*Proc.*, Vol. 39." All volume numbers correspond to the respective years. 1940 Supplement means the 1940 Supplement to the current Book of A.S.T.M. Standards, Part I, Metals; Part II, Nonmetallic Materials—Constructional; Part III, Nonmetallic Materials—General. References to the special compilations of standards covering specific fields are indicated, such as, 1940 "A.S.T.M. Standards on Petroleum," "on Textiles," etc.

Brief report on correlation of results of this project with other corrosion studies by the committee (*Proc.*, Vol. 36, Part I). Extensive data given showing rusting that has occurred on samples since 1935 report (*Proc.*, Vol. 38, Part I).

Atmospheric Corrosion Tests of Electroplated Coatings on Non-Ferrous Metals and Some on Steel (Joint Committee of A.E.S., National Bureau of Standards, and A.S.T.M.).—Investigation of value of electroplated coatings of nickel, copper, chromium, cadmium, zinc, or combinations of these metals, on specimens of copper, brass, nickel-brass, rolled zinc, zinc die castings, and iron after atmospheric exposure at six test locations. Tests also include continuation of certain specimens from earlier investigation of coatings on steel and some repeat tests on steel specimens. Progress report on inspection of plated coatings on non-ferrous metals at the six test locations given in ASTM Bulletin, April, 1937. Supplemental specimens prepared and exposed, including coatings on zinc-base die castings and specimens plated with bright nickel (*Proc.*, Vol. 38, Part I). For summary of conclusions of tests started in 1936 and 1938, see *Proc.*, Vol. 39.

Atmospheric Corrosion Tests on Wire and Wire Products (Committee A-5).—Studies started in 1936 at 11 test locations of wire and wire products, including unfabricated wire, barbed wire, wire strand, farm-field fencing, and chain-link fence. Materials to be tested include: Uncoated wire and fencing (both copper-bearing and non-copper-bearing), zinc-coated wire and fencing, corrosion-resistant steel wire and fencing, copper-covered wire and fencing, and lead-coated wire and fencing. Test sites are representative of atmospheric conditions from coast to coast. For detailed report on installation of test materials at exposure locations see *Proc.*, Vol. 37, Part I. Report of results of 2-yr. exposure tests at all locations and detailed data of referee tests at National Bureau of Standards to provide complete information on original characteristics of the material on test, including photomicrographs, etc. (*Proc.*, Vol. 39). Brief interim report included in Reprint of 1940 Report of Committee A-5. (*Note.*—A special publication "Wire Test Report," issued in 1939 gives the data from 1937 to 1939 *Proc.*).

Total Immersion Tests on Uncoated Sheets (Committee A-5).—Tests begun in 1920 on bare (uncoated) steel and iron sheets immersed in acid mine water at Calumet, Pa. (Completed, 1921; *Proc.*, Vol. 21, Part I); in saline water in Annapolis, Md. (Completed, 1930; *Proc.*, Vol. 30, Part I); in city water at Washington, D. C. (Completed, 1928; *Proc.*, Vol. 28, Part I); and beginning in 1927 in sea water at Key West, Fla. (Completed, 1939), and Portsmouth, N. H. (Completed, 1937); also tests in open sea water to determine the effect of corrosion on copper-steel pipe and on steel ship plate, with and without copper, when riveted with rivets of iron and steel with varying copper contents.

Final report on sheet specimens exposed at Portsmouth and Key West presented, characterizing the materials in the test, indicating the life of each specimen, and including such conclusions as the subcommittee has been able to draw. (Reprint, 1940 Report of Committee A-5, and *Proc.*, Vol. 40.)

Accelerated Corrosion Tests (Committee A-5).—Study of various methods of accelerated corrosion tests, with particular reference to their application to metallic-coated products. Symposium on Corrosion Testing Procedure held in 1937, comprising six papers on principles of testing, atmospheric corrosion, salt spray, alternate immersion and water-line tests, and total immersion and soil corrosion testing, also contributed discussion, issued as separate reprint.

Corrosion Tests of Stainless Steels (Committee A-10).—Laboratory corrosion tests completed on stainless steels restricted to four types, and three corrosion tests of the inspection type: namely, the du Pont acid-immersion test, the Navy Department salt spray test, and the copper-sulfate stain test. For details of test methods, data obtained, and discussion of results, see *Proc.*, Vol. 33, Part I. Work on tests and on inspection program to determine the utility of the various alloys resulted in publication as tentative of a recommended practice for conducting plant corrosion tests (A 224 – 39 T) (1939 Book of A.S.T.M. Standards, Part I) and a report on inspection of stainless steel installations on certain buildings in New York City, Philadelphia, Pa., and on the boardwalk at Atlantic City, N. J., including a recommended practice for decorative installations (*Proc.*, Vol. 39).

Standardization of the Practice of Corrosion-Resistance Testing (Committee B-3).—A study of four corrosion tests, namely, total immersion, alternate immersion, spray, and accelerated electrolytic. Six non-ferrous metals tested by a number of cooperating laboratories, each following carefully prescribed methods. Detailed description of procedure for each test, preparation of solutions and specimens, materials used, and critical discussion of each test, see *Proc.*, Vol. 32, Part I. A method of salt spray testing of non-ferrous metals (B 117 – 39 T) accepted (1939 Book of A.S.T.M. Standards, Part I). A study has been undertaken of methods of calibrating salt spray fog densities and of salt spray testing in large chambers; report not yet available.

Atmospheric Corrosion of Non-Ferrous Metals and Alloys (Committee B-3).—Comprehensive field corrosion studies started in 1931 at nine test locations from coast to coast, representing various atmospheric conditions, on 24 non-ferrous metals and alloys in the form of rolled sheet or strip. Corrosion over 25-yr. period to be measured. Data reported showing changes in weight and tensile properties after 1-, 3-, and 6-yr. exposures. Also visual inspection results and meteorological data at test locations during exposure periods (*Proc.*, Vols. 33, 35, and 38, Part I). Of related interest are two papers, one by C. W. Borgmann on "Atmospheric Corrosion of Non-Ferrous Metals and Alloys," and the other by E. A. Anderson and C. E. Reinhard on "Chemical Removal of Corrosion Products in the Determination of the Corrosion Rate of Zinc" (*Proc.*, Vol. 39).

Galvanic and Electrolytic Corrosion of Non-Ferrous Metals and Alloys (Committee B-3).—Study of galvanic effects (that is, effect of contact between dissimilar metals upon the rate of corrosion of each) at nine test locations representing various atmospheric conditions on galvanic couples of metals, used commercially under conditions of tests, and electrolytic action on couples of metals and alloys in hot water, sea water, NaOH and H_2SO_4. Includes study of stainless steel in contact with various non-ferrous metals. Record of corrosion after 1- and 3-yr. periods of exposure on couple combinations of zinc, aluminum, lead, tin, nickel, copper, and mild steel at nine test locations reported, see *Proc.*, Vols. 34 and 35, Part I.

In 1939 final report presented, including extensive data on corrosion occurring over 7-yr. period and a summary of results obtained in the two previous periods (*Proc.*, Vol. 39; also reprinted separately). Of related interest are two papers presented in 1940, one by F. L. La Que and G. L. Cox on "Some Observations of the Potentials of Metals and Alloys in Sea Water," and the other by W. A. Wesley on "The Influence of Cathode Area and Circuit Resistance in Galvanic Corrosion," see Preprint, 1940 Report of Committee B-3. Plans being formulated for tests on stainless steels coupled with other metals in atmospheric exposures to supplement former work, see Preprint, 1940 Report of Committee B-3 and *Proc.*, Vol. 40.

Corrosion of Non-Ferrous Metals and Alloys in Liquids—Field Tests (Committee B-3).—Testing metals in several common solutions under conditions representative of those in use in industrial processes. Metals used are those which may reasonably be expected to prove practicable for use in each process. The three solutions used were: NaOH, NaCl, and H_2SO_4. Data reported, see *Proc.*, Vol. 35, Part I. Final report presented in 1938 (*Proc.*, Vol. 38, Part I).

Total Immersion Tests of Non-Ferrous Metals (Committee B-3).—Total immersion tests to be conducted on commercial copper, phosphorized, in aerated and unaerated normal solutions of sulfuric acid, sodium chloride, and sodium hydroxide at 35 C. under closely controlled test conditions; 5 laboratories to cooperate. It is hoped that this work will lead to the formulation of a recommended practice for total immersion testing.

Ferrous and Non-Ferrous Metals, General

Welding of Malleable Iron Castings (Committee A-7).—To develop authentic information on the welding of malleable iron castings either in the hard condition or after annealing. Considerable work carried out by committee members but no report yet available.

Study of Grain Boundary Precipitation in Chromium-Nickel Alloy Steel (Committee A-10).—Investigation of the phenomenon of grain boundary precipitation in the 18 per cent chromium, 8 per cent nickel alloy steels with a view to determining the nature of the precipitate. Studies made on two heats of these steels in three conditions, quenched, medium, and badly precipitated as to carbide. Metallographic examination completed and data reported (*Proc.*, Vol. 39).

Effect of Temperature on the Properties of Metals (Joint Research Committee of A.S.M.E and A.S.T.M.).—The scope of these investigations includes (1) an accumulation of service data of various metals under high and low temperatures; (2) studies leading to standardization procedure for testing metals at high and low temperatures; and (3) outlining and fostering new research work in this field, giving consideration first to the various metals and alloys intended for high-temperature service in power stations, oil refineries, etc. See report of Joint Committee for 1931, *Proc.*, Vol. 31, Part I.

Symposium on Effect of Temperature on the Properties of Metals held at the 1931 annual meeting and published.

Tests for short-time and for long-time (creep) high-temperature tension tests of metallic materials developed; results of tests and other data in explanation of the test methods reported, see *Proc.*, Vol. 33, Part I.

The *Volume on Creep Data* (published in 1938) gives in the form of charts, tables, and graphs the very extensive data developed by the committee covering large numbers of steels, non-ferrous metals, and other metallic materials used at high temperatures (864 pages).

Current report includes detailed discussion on the study of effects of variables on the creep resistance of steels (second report), see Preprint, 1940 Report of Joint Committee and *Proc.*, Vol. 40. (*Note.*—Each annual report of the committee contains important information.)

Fatigue of Metals (Research Committee).—The broad purpose is to summarize and correlate the work that various laboratories are doing and to study the relationship between fatigue failure and other strength properties of metals and their atomic and metallographic structure. Consideration being given to method of studying fatigue phenomena by use of "probable damage line" for metals under repeated stress. 1933 Edgar Marburg Lecture by H. J. Gough on "Crystalline Structure in Relation to Failure of Metals—Especially by Fatigue," reprint pamphlet, also *Proc.*, Vol. 33, Part II.

Abstracts, prepared by the Research Committee, on fatigue studies appear currently in *Metals and Alloys*.

Pertinent notes and comments on fatigue studies and discussion on nomenclature for various ranges in stress in fatigue included in 1937 report (*Proc.*, Vol. 37, Part I). Program outlined for investigation on effect of type of testing machines on fatigue test results (*Proc.*, Vol. 38, Part I). Of related interest are the following three papers: "Fatigue Tests of Wire," by C. P. Wampler and N. J. Alleman; "Fatigue Strength of Machined Forgings 6 to 7 in. in Diameter," by O. J. Horger and H. R. Neifert; and "Fatigue Machines for Testing Structural Units," by R. L. Templin (*Proc.*, Vol. 39).

Effect of Type of Testing Machines on Fatigue Test Results (Research Committee on Fatigue of Metals).—See above project on Fatigue of Metals.

Chilled and White Iron Castings (Committee A-3).—Investigation of the properties of these irons. Work involves a study of the published literature on the testing of white iron and experimental work on transverse and tension testing of chilled iron. For a paper by S. C. Massari on "The Properties and Uses of Chilled Iron," see *Proc.*, Vol. 38, Part II.

Effect of Speed of Testing on Physical Properties of Metals (Committee E-1).—Studies of effect of different speeds of testing upon the yield point, ultimate strength, and other physical properties of metals. Results may be expected to form the basis of specification requirements for testing speeds. Autographic records will show simultaneous records of time, strain, and load from which the effect of rate of strain or rate of loading on test results can be determined. Tests being conducted at University of Illinois. Latest data on tension tests of 14 metals using different speeds of testing and special equipment reported in a paper by Paul G. Jones and H. F. Moore on "An Investigation of the Effect of Rate of Strain on the Results of Tension Tests of Metals," include proposed methods of determining speed to be used for tension tests (1940 Preprint and *Proc.*, Vol. 40). See also 1940 paper by Lawford H. Fry on "Speed in Tension Testing and Its Influence on Yield Point Values" (*Proc.*, Vol. 40).

General Study of Properties of Babbitt Metal (Committee B-2).—Certain portions of investigation completed. Studies on this subject reported by H. K. Herschmann and J. L. Basil on "Mechanical Properties of White-Metal Bearing Alloys at Different Temperatures" (*Proc.*, Vol. 32, Part II); by J. N. Kenyon on "The Effect of the Addition of Lead on the Hardness of Certain Tin-Base Bearing Alloys at Elevated Temperatures" and by C. E. Swartz and A. J. Phillips on "A Comparison of Certain White-Metal Bearing Alloys, Particularly at Elevated Temperatures" (*Proc.*, Vol. 33, Part II); and by J. N. Kenyon, "The Effect of the Addition of Lead on the Endurance Limit of a Certain Tin-Base Bearing Alloy," (*Proc.*, Vol. 36, Part II).

Investigation of Tin- and Lead-Base Die-Castings Alloys (Committee B-6).—A study of 5 tin- and lead-base alloys to determine tensile strength, creep, impact, and hardness. Composition of the alloys will be determined by chemical and spectrographic analyses (*Proc.*, Vol. 37, Part I). Results presented of preliminary tests (*Proc.*, Vol. 39).

Investigation of Aluminum-, Zinc-, and Magnesium-Base Die-Casting Alloys (Committee B-6).—An extensive investigation of die-casting alloys involving composition, strength, hardness, brittleness and resistance to corrosion; also finishing properties of die castings. Studies cover commercial compositions of aluminum-base, zinc-base, and magnesium-base alloys. Purpose of investigation is to supply dependable information on the properties of alloys suitable for die castings and the formulation of specifications based either on the alloys tested or on alloys developed as a result of the investigation. Several specifications have been issued, see Book of Standards.

Data showing physical properties of aluminum-base die-casting alloy specimens after 1-yr. exposure at 5 outdoor test locations and 4 indoor locations reported in *Proc.*, Vol. 32, Part I. For report on inspections of zinc-base die-cast specimens after 4-yr. exposure at 6 outdoor test locations, see *Proc.*, Vol. 34, Part I. Report for 1935 covers results of 5-yr. exposure tests of 12 aluminum and 10 zinc alloys cast by several producers and exposed at 6 outdoor and 4 indoor locations; data presented cover chemical analysis, tension, impact, and expansion tests; also description of photographic inspections of specimens of all alloys after 4-yr. outdoor exposure at 6 locations (*Proc.*, Vol. 35, Part I).

Aluminum alloy die-cast specimens of higher purity than that specified for Alloys Nos. IV and V have been extensively studied. Description of specimens, chemical analysis of alloys, and original mechanical properties reported in *Proc.*, Vol. 35, Part I. 1936 report contains results after 12, 26, and 52-weeks exposure to salt spray and after alternate immersion in salt solution; also paper by J. C. Fox on "Finishing of Die Castings" (*Proc.*, Vol. 36, Part I).

Corrosion test program expanded to include exposure of 4 magnesium-base alloys and 3 additional zinc-base alloys. Zinc alloys to be die cast in accordance with procedure outlined in paper by G. L. Werley on "A Study of Die Design Changes for the Improvement of the Soundness and Uniformity of Test Bars" (*Proc.*, Vol. 37, Part I). Chemical analysis and original physical test data on the new zinc and magnesium alloys presented (*Proc.*, Vol. 39). Five-year tests on 3 special aluminum-base alloys (Nos. 1 Va, Va, V) completed and results compiled (Preprint, 1940 Report of Committee B-6; also *Proc.*, Vol. 40).

Results of tests on 10 zinc-base die-casting alloys after 10-yr. exposure presented; also in 1940 Report.

X-ray Diffraction and Crystallography (Committee E-4).—Studies of the applications of X-ray diffraction methods in locating defects in

metals and crystallographic studies involving arrangement of atoms in crystals, size of grain, orientation of crystalline material, etc. Symposium on Radiography and X-ray Diffraction Methods held in 1936, comprising 12 papers issued as separate publications.

Study reported of X-ray diffraction as a means of detecting impending fatigue failure, carried on in cooperation with Research Committee on Fatigue of Metals (*Proc.*, Vol. 36, Part I).

Radiographic Testing (Committee E-7).—Investigation and promotion of the application of radiographic testing of materials involving both X-rays and gamma rays. New standing committee organized 1938 (*Proc.*, Vol. 38, Part I).

Symposium on Radiography and X-ray Diffraction Methods held in 1936, comprising 12 papers, issued as separate publication.

Numerous papers and reports published in ASTM BULLETIN and *Proc.*, Vol. 38 through 40 (list of papers furnished on request). Latest contribution—Topical Discussion on Radiographic Testing of Airplane Components—to be published in ASTM BULLETIN; also papers on "The Technique of Inspecting Wood Poles by X-ray" by Myron Zucker (October 1940 ASTM BULLETIN); "Reduction of Secondary Radiation and of Excessive Radiographic Contrast by Filtration" by H. E. Seemann; and "Precision Radiography—II" by G. E. Doan and W. H. Sharp, *Proc.*, Vol. 40.

Cement

Particle Size and Specific Surface of Cement (Committee C-1).—Development and studies of apparatus and procedures for determining sub-sieve gradation of particle-size and specific surface of cements. Cooperative studies reported on 4 cements by 25 laboratories of Wagner turbidimeter and other apparatus and methods (*Proc.*, Vol. 34, Part I). Method developed for fineness tests of cement using turbidimeter, C 115 – 38 T (1939 Book of Standards, Part II). Of related interest is a paper by H. S. Ponzer and D. R. MacPherson on "Studies of the Operation of the Wagner Turbidimeter" (*Proc.*, Vol. 38, Part II).

Investigation being conducted on relation between fineness of cement and amount of water which might separate after molding ("bleeding") and before initial set (*Proc.*, Vol. 39).

Volume Change and Soundness of Portland Cement (Committee C-1).—To obtain information on (1) volume change of neat cement bars when subjected to various temperatures and storage conditions and (2) the influence of cement on volume change characteristics of neat cement, mortar, and concrete under various conditions of storage. Extensive data reported (see *Proc.*, Vols. 34 and 36, Part I). A series of cooperative tests carried on by 10 laboratories resulted in development of method of test for autoclave expansion of portland cement, C 151 – 40 T, (1940 Supplement; see Preprint, 1940 Report of Committee C-1; also *Proc.*, Vol. 40 for detailed report with much data, on results of the cooperative studies).

Compressive Strength Tests of Cement Mortars (Committee C-1).—Development of satisfactory commercial test for compressive strength of portland-cement mortars. Extensive data reported and tentative method prepared (*Proc.*, Vol. 34, Part I). Consideration being given to problems inherent in compression test (C 109 – 37 T). Of related interest is a paper presented in 1936 by J. R. Dwyer on "Effect of Departure from Planeness of Bearing Surfaces on the Compressive Strength of 2-in. Mortar Cubes (*Proc.*, Vol. 36, Part II). Results of cooperative investigation by 14 laboratories on use of concrete instead of mortar as an acceptance test for cement reported (*Proc.*, Vol. 38, Part I). A supplementary series of tests of certain mortar mixes by 7 laboratories reported in Preprint, 1940 Report of Committee C-1; also, *Proc.*, Vol. 40.

Statistical study of three techniques for preparing 2-in. cubes reported by Subcommittee XI of Committee C-9 (*Proc.*, Vol. 37, Part I).

Concrete and Concrete Aggregates

Effect of Speed of Testing on Concrete (Committees C-9 and E-1).—Investigative studies on the effect of varying the speed of testing upon the strength and elastic properties of concrete. Tests carried out at University of Illinois reported in a paper by Paul G. Jones and F. E. Richart entitled, "The Effect of Testing Speed on Strength and Elastic Properties of Concrete" (*Proc.*, Vol. 36, Part II). A study also made of inelastic deformation as affected by rate of loading and particularly by the time interval that the load is held constant at each interval of loading; see paper by R. S. Jensen and F. E. Richart on "Short-Time Creep Tests of Concrete in Compression" (*Proc.*, Vol. 38, Part II). Project essentially completed.

Relation of Characteristics of Materials and Mixtures to Properties of Concrete (Committee C-9).—To study the effects of characteristics of materials and mixtures upon the properties of concrete. An important feature is a critical review of the existing information relating to the factors affecting the proportioning of materials for concrete.

Of related interest is a paper presented at 1938 annual meeting by H. J. Gilkey and Glenn Murphy on "Stress-Strain Characteristics of Mortars and Concretes" (*Proc.*, Vol. 38, Part I).

Studies of Concrete Aggregates (Committee C-9).—A study of the various properties of aggregates for concrete, including soundness, resistance to abrasion, absorption and influence of shape, fineness and soft particles on quality of concrete; also freezing-and-thawing tests. A number of tests developed for soundness (C 88 and C 137), abrasion (C 131), determining clay lumps (C 142), and others; also several specifications for aggregate (see 1939 Book of Standards, Part II). There was published in 1939 as information a proposed test for soundness by use of magnesium sulfate and a paper by C. E. Wuerpel in support of the method; also a proposed test for organic impurities in sand by pH Value and paper by Ira Paul in support of the method (*Proc.*, Vol. 39).

Admixtures in Concrete (Committee C-9).—For progress report containing a summary of manufacturers' data on various commercial admixtures, see *Proc.*, Vol. 29, Part I. Until new information is developed little progress can be expected toward the contemplated objectives. It is realized that admixtures are important and pending further developments this project is being held in abeyance by the committee (*Proc.*, Vol. 37, Part I).

Elastic Properties of Concrete (Committee C-9).—Studies of the elastic properties and volume changes of concrete of different mixtures at different ages under different conditions of moisture, the effect of different aggregates, a determination of the modulus of elasticity of concrete in tension, establishment of Poisson's ratio, and of the effect of application of loads, type of bearing, sensitivity of measuring devices, etc. See paper on "Plastic Flow of Concrete Under Sustained Stress" by R. E. Davis, H. E. Davis, and J. S. Hamilton (*Proc.*, Vol. 34, Part II); "Methods of Test for Determining Volume Changes in Concrete," by R. E. Davis (Vol. 35, Part I); "Shrinkage of Gravel and Haydite Concrete," by F. E. Richart and J. E. Keranen (Vol. 36, Part I); and "Thermal Volume Change and Elasticity of Aggregates and Their Effect on Concrete," by T. F. Willis and M. E. De Reus (Vol. 39).

Permeability of Concrete (Committee C-9).—Study of the literature followed by studies of various methods and apparatus including the significance of permeability and absorption of concrete and the value of blended cements in reducing permeability. See "A Study of the Permeability of a Few Integrally Waterproofed Concretes," by W. M. Dunagan and G. C. Ernst (*Proc.*, Vol. 34, Part I); "Apparatus and Technique for the Concrete Permeability Tests of the Bureau of Reclamation," by E. N. Vidal and G. A. Samson (Vol. 36, Part I); and "Some Observations of the Water Vapor Permeability of Concrete," by H. J. Barre, and "Methods of Measuring the Passage of Water Through Concrete," by W. M. Dunagan (Vol. 39).

Conditions Affecting Durability of Concrete in Structures (Committee C-9).—Study of the conditions under which concrete has not been durable. It will emphasize the precautions which must be taken to produce good concrete, whether in methods, material, or workmanship. Studies of freezing-and-thawing tests, methods for measuring the durability of concrete, and effects of admixtures and volume change on durability. For report on the examination of concrete structures in Ontario and Quebec together with observations and conclusions, see *Proc.*, Vol. 30, Part I. See papers by B. Kellam on "The Action of Water on Concrete" (Vol. 33, Part I), and by C. E. Wuerpel on "Factors Affecting the Testing of Concrete Aggregate Durability" (Vol. 38, Part I).

Curing of Concrete (Committee C-9).—Coordination and study of results of investigations of the curing of concrete looking ultimately to recommended methods of practice or specifications for curing. Five specifications adopted for various methods of curing concrete; specifications also adopted for sodium silicate for curing and a method of test developed for efficiency of materials for curing concrete (C 156 – 40 T) (see Preprint, 1940 Report of Committee C-9; also *Proc.*, Vol. 40).

Masonry Materials

Weathering Characteristics of Masonry Materials.—Study of the weathering characteristics of such masonry materials as brick, mortar, hollow masonry building units, slate, and building stone. For a report and for papers on this subject involving clay brick, by D. E. Parsons and by J. W. McBurney, see *Proc.*, Vol. 35, Part I. Also see papers by J. W. McBurney on "Water Absorption of Building Brick" (*Proc.*, Vol. 36, Part I) and on "The Freezing-and-Thawing Test for Building Brick" (Vol. 38, Part II); and by J. M. Hardesty on "Disintegration of Face Brick by Crystallization of Soluble Salt" (Vol. 39).

Extensive investigations of the factors affecting the resistance of clay building brick to frost action being carried on at National Bureau of Standards and Alfred University (see Preprint, 1940 Report of Committee C-15; also *Proc.*, Vol. 40).

Note.—The work of Committees C-9, C-15, and C-18 in the study of weathering characteristics and development of accelerated weathering tests is being coordinated through the Coordinating Committee on Weathering Characteristics. Symposium on Weathering Characteristics of Masonry Materials held in 1931, see *Proc.*, Vol. 31, Part II.

Paint and Paint Materials

Accelerated Tests for Protective Coatings (Committee D-1).—A study of accelerated weathering tests for such protective coatings as house paints, enamels, varnishes, lacquers and metal protective finishes; also correlation of the results with outdoor exposure tests. Specifications prepared for wood panels used in weather tests of paints and varnishes. (D 358 – 38).

Report for 1936 records results of two series of accelerated weathering tests on 6 varnishes applied on primed steel panels. Kauri reduction and photochemical embrittlement tests were also made. Report includes integrity rating of test panels and order of durability rating of the varnishes studied (*Proc.*, Vol. 36, Part I). For report on house paint exposure tests for gloss retention and chalking see *Proc.*, Vol. 37, Part I.

Symposium on Correlation Between Accelerated Laboratory Tests and Service Tests on Protective and Decorative Coatings held in 1937, comprising 25 papers and discussions; issued as separate publication.

For progress on these tests see *Proc.*, Vol. 38, Part I, and Vol. 39; also Preprint, 1940 Report of Committee D-1. A report on accelerated weathering tests of enamels on steel, and correlation with outdoor exposure to be included in *Proc.*, Vol. 40.

Evaluating Rust Resistance (Committee D-1).—Preparation of a pictorial scale for evaluating rust resistance. For preliminary report on this work, see December, 1939 ASTM BULLETIN; further report, with proposed standards, to be published shortly in BULLETIN.

Study of Hiding Power and Tinting Strength of Paint Pigments and Paints (Committee D-1).—See "Report of Cooperative Work on the Determination of Hiding Power of Wet Paints," and method of test for comparative hiding power of paints (*Proc.*, Vol. 32, Part I). See paper by J. W. Ayers on "A Discussion of the Accuracy and Utility of Methods of Test for Mass Color and Tinting Strength of Dry Color Pigments," G. F. A. Stutz on "The Tinting Strength of White Pigments," and R. H. Sawyer on "The Tinting Strength of White Pigments" (*Proc.*, Vol. 34, Part II).

Test procedures adopted for tinting strength of white pigments (D 332 – 36) and for tinting strength and mass color of color pigments (D 387 – 36) (see 1939 Book of Standards, Part II). Studies made of a new method for hiding power of paints, working at incomplete hiding and on a dry film basis, resulted in development of revised methods of test for relative dry hiding power of paints (D 344 – 39) and of white pigments (D 406 – 39) (*Proc.*, Vol. 37, Part I). Two latter methods adopted in 1939 (Vol. 39).

Paperboard Containers

Moisture Content of Paperboard and of Corrugated Fiberboard Containers (Committee D-6).—An extensive research program to secure data on the moisture content of container grades of paperboard and of corrugated fiberboard containers resulting from conditioning these products under several different procedures; and to determine the practicability of the methods of conditioning in relation to duplication of test results. Report compiled containing comprehensive data, distributed to members of working group.

Rubber Products

Automotive Rubber (Technical Committee A of Committee D-11, Functioning as a Joint S.A.E.-A.S.T.M. Committee).—Development of testing procedures and purchase specifications for automotive rubber products. Initial work concerned with motor mountings and related articles. Program divided into following sections: classification and tests of motor mountings, of bumper parts, and development of standards for brake vacuum and air hose. Extensive work under way in Section I to develop suitable hardness tester. For current progress, including development of methods of testing automotive hydraulic brake hose (D 575 – 40 T), see Preprint, 1940 Report of Committee D-11; also *Proc.*, Vol. 40.

Vibration Absorption of Rubber Products (Committee D-11).—Study, development, and standardization of methods of test which are particularly suitable in the evaluation of rubber stocks for shackles, motor supports, bumpers, and shock insulators. Studying effect of repeated compression on rubber compounds and flow properties of rubber. Method of test for compression set of vulcanized rubber used for vibration absorption issued as tentative (D 395 – 40 T) (1940 Supplement).

Further investigation to be made of Methods D 395, including both the method of measuring thickness and the matter of using decay of load as an index of set rather than change in dimensions. Not yet reported.

Properties of Rubber and Rubber-Like Materials in Liquids (Committee D-11).—Study of volume changes of rubber compounds when subjected to the action of oils or various solvents and the development of suitable test methods for comparing the swelling properties. See paper by O. M. Hayden, "The Testing of Rubber and Rubber-Like Materials for Oil Resistance" (*Proc.*, Vol. 34, Part II). Determination of suitable shape and size of test specimens for a standard test studied by five cooperating laboratories (*Proc.*, Vol. 35, Part I). Conclusions resulting from study of factors affecting rate of deterioration of specimens in such tests reported (*Proc.*, Vol. 37, Part I) and methods of test for changes in properties of rubber and rubber-like materials in liquids issued as tentative (D 471–40 T) ("1940 A.S.T.M. Standards on Rubber Products").

Abrasion Tests for Rubber Products (Committee D-11).—Development of abrasion tests for application to those rubber products where abrasion in service is the most important element in determining the life of the material, such as conveyor belting, automobile tires, rubber-covered air and water hose, rubber heels, etc. Procedures covering widely used tests standardized (D 394 – 40) (1940 Supplement; also special standards compilation). Standard rubber test specimens having certified and tested properties for use as a reference base in testing have been established (*Proc.*, Vol. 38, Part I). A proposed method for determining tear resistance of vulcanized rubber to be published as information in *Proc.*, Vol. 40 and in 1940 "A.S.T.M. Standards on Rubber Products."

Boiler Feedwater

Studies of Boiler Feedwaters (Joint Research Committee under Joint Sponsorship of Six Societies).—Investigative research on boiler feedwaters including studies of caustic embrittlement, coagulation and sedimentation, foaming and priming, organic chemicals in water treatment, electrolytic prevention of scale and corrosion, effects of treated water in accelerating or relieving corrosion, effect of solution composition on cracking of boiler metal, and steam-metal reactions at high temperatures. See three papers on the determination of oxygen in boiler water, effect of solution composition on boiler steel, and the use of solubility data to control the deposition of sodium sulfate (*Proc.*, Vol. 36, Part II).

1937 report covers study of effect of solution on the intercrystalline cracking of boiler steel, including investigation of production of cracking and of prevention of cracking; progress reported on other studies, see ASTM BULLETIN, August, 1937.

Group engaged in study of caustic embrittlement concludes that lignins prevent the development of intercrystalline cracking in steel specimens stressed under a static load or in a reversing torsional load. Work of this group extended; see ASTM BULLETIN, No. 93, August, 1938. Seven standard methods of sampling industrial waters and determining various ions issued (D 510 through D 516) and method of reporting results of analysis (D 596) (1939 Book of Standards and 1940 Supplement). For progress on caustic embrittlement and other studies, see ASTM BULLETIN, No. 99, August, 1939.

Part II—Research on Methods of Testing

Ferrous and Non-Ferrous Metals

Tests for Weight and Uniformity of Zinc Coatings (Galvanized) (Committee A-5).—Extensive studies on tests for determining weight and uniformity of zinc coatings on hardware and irregularly shaped articles. Current report includes a tentative method of test for uniformity of coating by the Preece test on zinc-coated iron or steel articles (A 239 – 40 T), intended to replace when adopted the test on iron or steel wire (A 191 – 38) and iron or steel castings (A 208 – 38 T); see Reprint, 1940 Report of Committee A-5; also *Proc.*, Vol. 40. Studies on weight of coating methods continuing.

Tests for Weight or Thickness of Plated Coatings (Committee A-5).—Studies of several methods, including metallographic, stripping, the chord method, dropping, jet, and spot tests, and magnetic method (nickel coatings). Methods of test for local thickness of electrodeposited coatings on steel issued as tentative in 1939 (A 219 – 39 T), including a microscopic method for determining the thickness of zinc, cadmium, copper, and nickel coatings on steel, and a hydrochloric acid spot test method for determining the thickness of chromium coatings (1939 Book of Standards, Part I).

Recommended Practice for Dilatometric Analysis (Committee E-4).—Development of a method of procedure. Survey of present practices being made and opinions on various phases of the subject being obtained.

Alternating Current Tests of Magnetic Materials (Committee A-6).—Tests of magnetic materials used in apparatus operating at high frequencies (audio frequencies) and low inductions, such as core materials for audio-frequency transformers, chokes, etc. Methods of test for magnetic properties of iron and steel developed (A 34 – 39) (1939 Book of Standards, Part I). Further study being given to problems relating to a-c tests for permeability and core loss at low and high inductions; also to magnetic drift with time as result of demagnetization.

Method of test developed for measuring interlamination resistance and lamination factor of iron and steel (A 34 – 40 T) (1940 Supplement, Part I). Round-robin tests under way on half-length Epstein specimens both for (1) core loss and permeability tests, and (2) to develop a test for magnetic properties under conditions of combined alternating and direct magnetization (*Proc.*, Vol. 39; Preprint, 1940 Report of Committee A-6 and *Proc.*, Vol. 40).

Tests at High Magnetizing Forces (Committee A-6).—Development of test methods operating at high magnetizing forces in order to test materials which have coercive forces of several hundred oersteds. The saturation permeameter and the simplex Super-H Adapter incorporated in the standard methods of test for magnetic properties (1939 Book of Standards, Part I). Results given of round-robin tests on two high coercive force magnet steel bars of the Alnico type (Preprint, 1940 Report of Committee A-6; *Proc.*, Vol. 40).

A standard method for the measurement of permeability of the so-called nonmagnetic steel materials to be formulated.

Life Test for Durability of Electrical-Resistance Wire at High Temperatures (Committee B-4).—To arrive at the best methods for determining the durability of resistance wire at high temperatures with due regard to service conditions. Standard accelerated life test adopted (B 76 – 39). The effect of the humidity of the atmosphere upon the life of electric heater wires is being investigated.

A study of the effect of ceramics and cements upon the life of heating element materials in contact with them is being made. Also, comparative tests are being made on nickel-chromium wire using the accelerated life test (B 76) in comparison with a so-called constant temperature test in which the temperature is adjusted every 24 hr. to the starting temperature. No report available.

Electrical Tests of Heating and Resistance Alloys (Committee B-4).—Studies of methods of test for thermoelectric power of materials and for temperature coefficient of resistance. Standard methods adopted for thermoelectric power (B 77 – 33), resistivity (B 63 – 36), change of resistance with temperature (B 70 – 39), and temperature-resistance constants (B 84 – 36); also, a standard method for temperature-resistance constants of sheet materials for shunts and precision resistors (B 114 – 39) (1939 Book of Standards, Part I).

Program of work has been prepared to develop standard methods of test for electrical contact metals suited for currents in the range of 0.1 to 50 amp. Tests are being made with two different contacting devices. No report available.

Mechanical Tests of Heating and Resistance Alloys (Committee B-4).—Investigations of tests for determining stiffness and elastic properties of electrical resistance wires. Three types of bend testing machines together with a torsion test were studied by comparative tests on nickel wire, and a method for bend testing of wire (wire for radio tubes and incandescent lamps) (B 113 – 38 T) was issued as tentative in 1938 (1939 Book of Standards, Part I). It is planned to extend the bend test to cover strip as well as wire. A resilience test which is in use for strip (determined by the amount of spring back when flexed) is being investigated. No report available.

Studies of Heating and Resistance Alloys at High Temperatures (Committee B-4).—Tests for thermal conductivity, tests for thermal coefficient of linear expansion, and a study of warpage to determine its relation to thermal expansion and heat conductivity. Test developed for linear expansion of metals (B 95 – 39) and appendix to methods of test for short-time high-temperature tension tests of metallic materials covering preparation of cast tension specimens of heat resistant metals prepared (1939 Book of Standards, Part I). Consideration also being given to oxidation, corrosion, and compression tests at high temperatures as well as a high-temperature bend test for use on bars, employing a small electric furnace in which the bars are tested. No report available.

Tests for Evaluating Thermostatic Metals (Committee B-4).—Survey of methods of test for "thermoflex" (thermostatic metals); also preparation of units and definitions of terms used in connection with the specifying and testing of these metals. Test for flexivity (flexure-temperature characteristics) of thermostat metals (B 106 – 40) adopted (1940 Supplement, Part I). Methods of test for hardness and for electrical resistance being prepared.

Tests for Metallic Materials for Radio Tubes and Incandescent Lamps (Committee B-4).—Substantially as stated by title. Proposed program divided among five sections; on strip, wire tubing, coated material, and powdered materials and liquids. Methods of testing nickel and nickel-alloy wire and ribbon for electronic tube filaments (B 118 – 39 T) and a method of testing sleeves and tubing for radio tube cathodes (B 128 – 40 T) issued as tentative (1939 Book of Standards, Part I, and 1940 Supplement). Considerable work being done on testing the thickness of nickel plating on thin steel strip using the magnegage. Methods of test for stiffness, brittleness, and hot tensile strength of tungsten wire are under consideration. Also 3 laboratories are working on high-temperature tests of filament materials for radio tubes. No report available (see also project described above on Mechanical Tests of Heating Alloys).

Effect of Controlled Atmospheres upon Electric Furnace Resistors and Structures (Committee B-4).—Study of a suitable method of test to determine the durability of resistor alloys exposed to controlled atmospheres at high temperatures in electric furnaces. A study being made by 4 laboratories of the action of "combusted gas" atmospheres on nickel-chromium resistor alloys (Preprint, 1940, Report of Committee B-4; also *Proc.*, Vol. 40).

Tests of Anodic Oxidation of Aluminum and Aluminum Alloys (Committee B-7).—Study of methods of tests for anodized coatings and the ability of such coatings to withstand various service conditions. 1937 report contains accumulated data and information on methods of testing oxide coatings on aluminum, including tests for thickness, resistance to abrasion, and measurement of insulating value (electrical breakdown voltage) of oxide coatings (*Proc.*, Vol. 37, Part I).

Methods of test for dielectric strength of anodized aluminum issued as tentative (B 110 – 39 T) (1939 Book of Standards, Part I). Also, methods of test for sealing of anodically coated aluminum (B 136 – 40 T) and for weight of coating (B 137 – 40 T) published as tentative this year (1940 Supplement, Part I).

Of related interest are 4 papers presented at the 1940 annual meeting covering thickness, abrasion resistance, electrical breakdown, and use of the microscope (Preprint No. 19); for current progress, see Preprint, 1940 Report of Committee B-7; also *Proc.*, Vol. 40.

Tests of Light Metals (Committee B-7).—Study of various problems relating to testing of aluminum alloys and magnesium alloys, including tensile properties, hardness tests, effect of speed of testing, effect of foundry technique on physical properties of cast test bars including effects of design, gating, and chilling. Study reported by R. L. Templin and Sam Tour in paper on "Modulus of Elasticity of Aluminum Alloys" (*Proc.*, Vol. 37, Part I) and by H. J. Rowe on "Effect of Foundry Variables on Mechanical Properties of Sand-Cast Tension Test Specimens (*Proc.*, Vol. 38, Part I).

Results of cooperative work with Section on Effect of Speed of Testing (under Committee E-1 on Methods of Testing) reported at 1940 annual meeting in a paper by Paul G. Jones and H. F. Moore on "An Investigation of the Effect of Rate of Strain on the Results of Tension Tests of Metals" (Preprint No. 49; also *Proc.*, Vol. 40).

Cement and Lime

Chemical Analysis of Cement (Committee C-1).—Study of improved and shorter methods for chemical analysis of cement. Study completed of tests for manganese and phosphorus in cement and procedures issued (*Proc.*, Vol. 37, Part I). Cooperative work resulted in development of an alternate quick method for the determination of manganic oxide; also, new methods for the determination of sodium oxide and potassium oxide (*Proc.*, Vol. 38, Part I).

A very extended cooperative series of tests for the determination of free lime in cement reported in ASTM Bulletin (No. 94, October, 1938) and in *Proc.*, Vol. 39. New methods issued for determining silicon dioxide, calcium oxide, and magnesium oxide; proposed methods for acid-soluble sodium oxide and potassium oxide, and water-soluble alkali in portland cement published as information; extensive study completed by 10 cooperators on quick methods for phosphorus pentoxide; also on methods for vinsol resin and tallow (Preprint, 1940 Report of Committee C-1; also *Proc.*, Vol. 40).

Time of Setting of Portland Cement (Committee C-1).—Development of an improved method for determining time of setting of cement. 1939 report (*Proc.*, Vol. 39) gives brief discussion, mentions some comparative work and indicates that present methods must be improved. "Any test for time of setting, in order to give dependable results, will require even closer control of conditions and manipulations than most of the other physical tests, because of the fact that the physical properties of the cement are changing very rapidly at the time the test is performed."

Determination of Soundness of Lime (Committee C-7).—Study of methods for determining soundness of lime, particularly adapted to lime used for plastering. Experimental work at National Bureau of Standards resulted in development of autoclave test for soundness of lime issued as tentative method (C 110) (*Proc.*, Vol. 34, Part I) which later, however, as indicated in the 1939 Report, was found unsatisfactory since it produced laboratory results at variance with field experience; test dropped (*Proc.*, Vol. 38, Part I). Other test methods are under consideration.

Fire Tests

Studies of Size of Samples for Fire Tests of Materials and Construction (Committee C-5).—Scope of studies includes (1) inquiry into the effect of size of samples on test results; (2) what types of information can be obtained on samples smaller than the standard size for given types of construction; (3) under what conditions information on load-carrying ability can be obtained from temperature measurements without load application; and (4) the necessary distribution of thermocouples and other measuring appliances to obtain reliable results. Data obtained have resulted in a tentative revision of the standard specifications for fire tests of building construction and materials (C 19) (see Preprint, 1940 Report of Committee C-5; *Proc.*, Vol. 40).

Concrete

Field Tests for Concrete (Committee C-9).—Standardization of methods of making field specimens, including sampling of the concrete when soft, the methods of sampling hardened concrete, and the development of field tests for concrete. Study of relation between the strengths of test specimens of different forms and dimensions. Methods of testing vibrated concrete and an accelerated compression test being studied. Test methods for flow of portland-cement concrete by use of flow table (C 124 – 39), making and storing compression specimens in the field (C 31 – 39), securing specimens of hardened concrete (C 42 – 39) and others. See 1939 Book of Standards, Part II.

Durability of Concrete (Joint Committee of Highway Research Board (National Research Council), American Concrete Institute, and A.S.T.M.).—To undertake a fundamental study of the phenomena of freezing and thawing and of the property of durability in general, looking to the establishment of basic principles upon which standard procedure may ultimately be based.

Structural Clay Tile

Capping Structural Clay Tile (Committee C-15).—Investigation of methods of capping structural clay tile, comparisons obtained between various types of filling for the recesses of bonding tile as well as between different materials for capping. Tests completed at Rensselaer Polytechnic Institute (*Proc.*, Vol. 37, Part I), but not yet published.

Refractories

Load Test of Refractories (Committee C-8).—A study of methods for performing load, reheat, and flexure tests on refractories has resulted in a revised test for refractories under load at high temperatures (C 16 – 39 T) which omits the test for silica brick and stipulates certain conditions which have been in general use but which were not incorporated in the former procedure. Three types of furnaces are covered, of which two are new designs employing a direct load in place of a lever; one furnace is heated electrically; the second makes use of gas or oil (1939 Book of Standards, Part II).

Pyrometric Cone Equivalent (P.C.E.) Test for Refractories (Committee C-8).—Investigation of uniformity and dependability of P.C.E. results obtained with air-gas, oxygen-acetylene, and granannular carbon resistance furnaces. Study made of rate of heating in P.C.E. test, and on variations in sizes of pyrometric cones. For discussion by F. A. Harvey of "P.C.E. *versus* Fusion Point," see *Proc.*, Vol. 34, Part I.

Current report includes a recommendation in connection with supplying uniform test cones Nos. 19 to 42 (small cones) for use in determining P.C.E. according to Standard Method C 24 – 35 (Preprint, 1940 Report of Committee C-8; also *Proc.*, Vol. 40).

Slagging of Refractories (Committee C-8).—A review has been prepared of the literature on slag tests developed and used in recent years. Comparatively little is being done on this test except the continuation of work at the University of Illinois with respect to minor changes in equipment and the correlation of test data with actual service trials. No report available.

Service Spalling Test of Refractories (Committee C-8).—Study of a service spalling test for refractories that will measure resistance to a variety of factors causing spalling, such as vitrification produced by time, temperature, and slag coatings, and to learn the effect of varying the temperature and rate of cooling. Three panel test methods adopted for resistance of refractory brick (C 38 – 36), of high heat duty fireclay brick (C 107 – 40), and of super duty fireclay brick (C 122 – 40) to thermal and structural spalling. The last two have just been revised (furnace gas pressure) (Preprint, 1940 Report of Committee C-8; also *Proc.*, Vol. 40). Present work, in cooperation with the Refractories Fellowship at Mellon Institute, is concerned with a revised design for the back-up insulation, used during the preheating period, of the panels in the spalling test. No report available.

Heat Transfer of Refractory Materials (Committee C-8).—Study of methods of determining and of expressing thermal conductivity, of high-temperature refractories and also of materials commonly classed as heat insulators, and to formulate standards to measure their physical

properties. Methods developed for testing insulating fire brick (compressive strength, flexual strength, permanent linear change after heating) (C 93); also symbols for heat transmission published (C 108) (1939 Book of Standards, Part II). Recommended procedures for calculating heat losses through furnace walls published as information in 1940 Manual of A.S.T.M. Standards on Refractory Materials, separate reprint pamphlet.

Comparative tests completed on block insulation to determine accuracy which may be expected when using present-day procedures and equipment. At 1300 F., the maximum variation was about 22 per cent, or a plus or minus variation of 11 per cent. At lower mean temperatures, the agreement was not so good.

Cooperative work with National Bureau of Standards being continued on methods of determining thermal conductivity, at high temperatures, rather consistent results being obtained with a flow calorimeter (Preprint, 1940 Report of Committee C-8; also *Proc.*, Vol. 40).

Masonry Mortars

Properties and Tests for Masonry Mortars (Committee C-12).—To formulate test methods and specifications which will describe how to test mortars and define their required properties so that they will be suitable for service. Work to cover studies of efflorescence, workability and plasticity of mortar, soundness and volume change, mortar for glass block, for reinforced brick masonry, and for concrete masonry units. Proposed methods of sampling and testing mortar for unit masonry together with discussion published in ASTM Bulletin, No. 94, October, 1938. Of interest in this work is a paper presented at 1940 annual meeting on "Some Properties of Mortar in Masonry" by F. O. Anderegg (see Preprint No. 74; also *Proc.*, Vol. 40). For current progress see preprint, 1940 Report of Committee C-12; also *Proc.*, Vol. 40.

Paints and Naval Stores

Physical Properties of Paint Materials (Committee D-1).—Study of the physical properties connected with paints and paint materials. Work involves a study of "gloss" including (1) preparation of a precise scientific definition of gloss, (2) investigation of the related merits of all instruments and apparatus that are commercially available, and (3) to obtain information and data for the development of a satisfactory gloss specification and method of test (*Proc.*, Vol. 36, Part I). Methods of test for spectral apparent reflectivity of paints (D 307) and specular gloss of paint finishes (D 523) issued (1939 Book of Standards, Part II). Paper by R. S. Hunter and D. B. Judd on "A Method of Classifying Paints According to Gloss," published ASTM Bulletin, March, 1939. Progress reported on studies of a method for specifying a color that would be so readily understood that the appearance of the color could be easily visualized from its notation. See also report on "Methods of Designating Colors" by D. B. Judd and K. L. Kelly, *Journal of Research*, National Bureau of Standards. Reprints available from Superintendent of Documents.

Properties and Tests of Varnishes (Committee D-1).—Studies of the physical and chemical properties of varnishes including tests for adhesion, color, method for determining reactivity of varnishes, study of the drying time and methods for measurement, methods of evaluating failure of varnishes upon exposure and effects of temperature, humidity and other factors upon physical properties of varnishes. Procedures developed for skinning test, alkali resistance and determining acid number of oleo-resinous varnishes (D 154 – 38) and for reactivity of paint liquids (D 479 – 40) (1939 Book of Standards, Part II). Latter describes the test procedure and system of rating the degree of thickening of varnishes, resin solutions, etc. Test for phthalic anhydride content of alkyd resin solutions (D 563) and methods of testing liquid driers (D 564) issued as tentative (1940 Supplement). See papers covering development of these tests, by Messrs. Sanderson and Pearce, ASTM Bulletin, October or December, 1940.

Shellac (Committee D-1).—General studies of properties and methods of tests of shellac and shellac varnish. Various developments discussed in committee reports, 1937 through 1940 (see *Proc.*, Vols. 37 to 40). For proposed test for color of orange shellac, developed in round-robin series of tests, see p. 49, ASTM Bulletin, August, 1940.

Consistency of Paint (Committee D-1).—Method to be standardized for determining the consistency of enamel-type paints; consideration to be given in this work to the Stormer viscosimeter, Gardner-Parks mobilometer, A.S.T.M. consistency cup specified for nitrocellulose lacquers, and the Ford cup. Results reported of cooperative tests on five paints using the four instruments. In view of good agreement of results obtained with the Stormer viscosimeter (fork-type rotor) a method of test for the consistency of enamel type paints based on this apparatus issued as tentative (D 562) (1940 Supplement). For results of tests see Preprint, 1940, Report of Committee D-1; also *Proc.*, Vol. 40).

Painting of Structural Iron and Steel (Committee D-1).—Series of tests being conducted, the object being to apply various chemical inhibitive treatments and mechanical pre-treatments to steel and note the relative advantages or disadvantages. For current progress, see Preprint, 1940 Report of Committee D-1; also *Proc.*, Vol. 40.

Tests of Bituminous Coatings for Underground Pipe Protection (Committee D-1).—Substantially as covered by title, particularly the development of satisfactory test for adhesion and a method of testing the durability of these and other paint coatings, and data based on such tests. For statement on principles of testing paints and combinations of paints on steel panels, see *Proc.*, Vol. 35, Part I.

Final official inspection commenced in March of this year of underground pipe coatings installed by National Bureau of Standards in cooperation with pipe line companies and steel pipe and coating manufacturers. The various coatings have been underground for about 10 yr., in 15 test locations that include a wide variety of soils. A preliminary report of the results will be made at the annual meeting in November of the American Petroleum Institute.

Properties and Tests for Rosin (Committee D-17).—Study, development, and standardization of various necessary tests for rosin. Study of methods for determining crystallization tendency of rosin reported (*Proc.*, Vol. 34, Part I). Data obtained in applying falling-ball viscosity method to rosin included in 1935 report (Vol. 35, Part I). Tests made on determination of ash in rosins, and the extent of darkening on heating of rosin for varnish making. Methods of test for acid number and saponification number of rosin issued in 1937 as tentative (D 465, D 464) (1939 Book of Standards, Part III). 1937 report includes data in support of the test methods (*Proc.*, Vol. 37, Part I). Current work covers study of low-temperature heat treatment method for determining the crystallizing tendency and method for determination of petroleum ether, insoluble matter and ash in rosin (*Proc.*, Vol. 38, Part I; Vol. 39; and Preprint, 1940 Report of Committee D-17; also *Proc.*, Vol. 40.)

Petroleum Products and Lubricants

Melting Point of Grease (Committee D-2).—Study of the pressure-flow relationship of greases, including the consistency of very soft greases, development of laboratory method indicative of point at which gear lubricants might channel in service, and improvement in grease worker for penetration method. Method of test for dropping point, D 566, issued this year; current report also includes data comparing new method and proposed method published as information in 1937 (see 1940 "A.S.T.M. Standards on Petroleum"; also *Proc.*, Vol. 40).

Gum in Gasoline (Committee D-2).—Investigative study of determining gum in gasoline by various methods and behavior of fuels in service; also the gum stability of gasoline. For discussion of studies of various bomb tests and the copper dish method, see *Proc.*, Vol. 34, Part I. Procedure for gum content of gasoline (D 381 – 36) (see 1940 "A.S.T.M. Standards on Petroleum"; also 1939 Book of Standards, Part III). Results reported in 1939 of a comprehensive series of tests extending over a 5-yr. period, resulting in a method of test for gum stability of gasoline (using bomb test) (D 525 – 40 T) (1940 "A.S.T.M. Standards on Petroleum)".

Kinematic Viscosity Tests (Committee D-2).—Study of methods for determining kinematic viscosity of any petroleum product or lubricant which is a true viscous liquid at the temperature of the test. Methods using the suspended level and modified Ostwald instruments, and a method for conversion of kinematic viscosity to Saybolt Universal viscosity issued (D 445 and D 446). Method of calculating viscosity index (D 567 – 40 T) issued as tentative (see 1940 "A.S.T.M. Standards on Petroleum"). Extensive viscosity-index and viscosity-conversion tables issued, separate reprint. See also separate pamphlet on "Evaluation of Petroleum Products."

Neutralization Number of Petroleum Products and Lubricants (Committees D-2 and D-9).—Cooperative study of revised methods for determination of acidity of oils. Draft of proposed revised method published as information together with data obtained by the use of the proposed method on used oils which do not emulsify badly or color alcohol excessively; also comparative data by the proposed and present methods (D 188 – 27 T) on two new oils (1940 "A.S.T.M. Standards on Petroleum").

Carbon Residue Test (Committee D-2).—A comparison of six oils by the Conradson carbon residue test (D 189) and the Ramsbottom method of the Institute of Petroleum of Great Britain. Results of tests tabulated and Ramsbottom method issued as tentative (D 524) in 1939, see *Proc.*, Vol. 39. Method was revised in 1940 by substituting a metal coking bulb for the glass bulb; supporting data given (1940 "A.S.T.M. Standards on Petroleum").

Classification of Transmission Lubricants and Automotive Greases (Committee D-2).—An attempt is being made to determine the relationship between viscosity of transmission lubricants under pressure and gear shifting in cold weather; also classification of automotive greases based upon consistency and viscosity of mineral oil content. Proposed classification recently issued by Lubricating Grease Institute.

Tetraethyl Lead in Gasoline (Committee D-2).—Development of a method of test. Work under way for 2 yr. resulted in 1939 in a standardized test method (D 526) which is the most accurate of any of those used for extracting lead from gasoline (*Proc.*, Vol. 39, p. 409; also 1940, "A.S.T.M. Standards on Petroleum").

Acid Heat of Gasoline (Committee D-2).—Results reported of cooperative tests of six laboratories on three samples of gasoline obtained by the use of the proposed method of test for acid heat of gasoline (*Proc.*, Vol. 38, Part I). Test method adopted, see 1940 "A.S.T.M. Standards on Petroleum."

Bituminous Materials

Method of Separation of Cut-Back Asphalt (Committee D-4).—Studies of various methods for the separation of cut-back asphalts to determine the amount and character of the base and cut-back. Extensive investigations included studies of atmospheric distillation, steam distillation, and vacuum distillation methods. Test for separation of liquid asphaltic products adopted (D 402 – 36) (see 1939 Book of Standards, Part II). Of related interest are two new specifications for cut-back asphalt of two types, medium curing (D 598) and rapid curing (D 597) (1940 Supplement).

Tests of Bituminous Emulsions (Committees D-4 and D-8).—Investigations of testing methods for bituminous emulsions for use on roads and also emulsions used for waterproofing generally, whether vertical or horizontal, and with or without membranes. General test procedures (D 244) adopted as standard (1940 Supplement). Cooperative test program resulted in development of new test procedures for resistance to water action and the ability to withstand flow at elevated temperatures (D 466) (1939 Book of Standards, Part II).

Accelerated Weathering Tests of Bituminous Roofing Materials (Committee D-8).—Study of an accelerated weathering test applicable to roofing. Information on radiant energy of alternating-current lamps and direct-current lamps reported; also proposed draft of an accelerated weathering test for bituminous materials published as information (*Proc.*, Vol. 33, Part I). Further data obtained on effect of accelerated weathering cycle as compared with outdoor weathering (Vol. 35, Part I). Studies of interest in this work are described in paper by O. G. Strieter entitled, "The Effect of Mineral-Fillers on the Serviceability of Coating Asphalts" (Vol. 36, Part II). 1937 report contains description of the weathering cycle, generally used in the proposed accelerated test (Vol. 37, Part I). Recommended practice for accelerated weathering test (D 529 – 39 T) issued as tentative (1939 Book of Standards, Part II). A new technical committee on conditioning and weathering under Committee E-1 on Methods of Testing has been organized to act as the coordinating group in this field.

Tests of Bituminous Joint Compounds for Sewer Pipe (Committee D-8).—Substantially as covered by title. Consideration being given to pressure tests and methods for determining solvent action of sewage on bituminous sewer joint compounds. Work carried on at University of Illinois, see paper by J. S. Crandell on "Bituminous Joint Compounds for Sewer Pipe" (*Proc.*, Vol. 34, Part II).

Tests for Mineral Surfacing Materials on Roofing (Committee D-8).—Development of tests for determining the effectiveness of imbedding of granular mineral surfacing in the asphalt coating of the weather surface of asphalt-prepared roofing and shingles. Series of cooperative tests with three type of machines described in paper by H. W. Greider and G. A. Fasold on "A Comparison of Abrasion Test Methods for Imbedding of Granular Mineral Surfacing on Asphalt Roofing" (*Proc.*, Vol. 36, Part I). Methods of test for sieve analysis of granular (D 451) and nongranular (D 452) mineral surfacing for asphalt roofing and shingles published. Results of cooperative test studies of the methods also presented (Vol. 37, Part I). Methods adopted this year (1940 Supplement).

Study of Test for Loss on Heating of Oil and Asphaltic Compounds (Committee D-4).—A series of comparative tests conducted pertinent to Method D 6 – 39 T using 3 ovens of different size and design for the purpose of testing the requirements for ventilating openings. From the results which are summarized in Preprint of 1940 Report of Committee D-4 (also *Proc.*, Vol. 40) it is concluded that the degree of ventilation in ovens through which the heated air is circulated by natural convection is not a critical feature of the test method within practical limits.

Timber

Moisture in Timber (Committee D-7).—Consideration of methods for making two types of moisture determinations applicable to timber, the first an accurate method for laboratory use and the second a method sufficiently accurate and practical for field use. Proposed draft of method for determination of moisture in timber for use in the laboratory published as information, *Proc.*, Vol. 29, Part I. Study made of application of electrical measurements to heavy timber, see *Proc.*, Vol. 33, Part I. For report with data on use of steam pipe oven for moisture content determinations, see *Proc.*, Vol. 36, Part I.

Gaseous Fuels

Tests for Gases Used as Commercial Fuels (Committee D-3).—Development and formulation of standard methods of procedure for the following determinations of gaseous fuels; calorific value, specific gravity, impurities, water vapor content, complete analysis or chemical composition, collection and measurement of samples, see Preprint, 1940 Report of Committee D-3; also *Proc.*, Vol. 40, for brief progress reports on each project—all are actively under way. Of related interest are two papers presented in 1939, "Recent Experiments on Laboratory Wet Gas Meters" by H. S. Bean and F. C. Morey, and "The Determination of Organic Sulfur in Gases by the Catalytic Hydrolysis Method" by L. I. Jilk (*Proc.*, Vol. 39).

Coal and Coke

Sampling of and Tolerances for Coal (Committee D-5).—A series of sampling experiments to test the accuracy of the present standard method of collecting and reducing gross samples of coal. Experiments of both hand and machine sampling methods on a number of different coals varying in size, and containing different amounts of impurities. Study resulted in proposed revisions of the standard methods of sampling coal to provide a procedure for the reduction of gross samples by means of mechanical crushers and riffle samplers (*Proc.*, Vol. 37, Part I); revisions adopted this year (Preprint, 1940 Report of Committee D-5). Method of sampling coals classed according to ash content (D 492) issued as tentative in 1938 (Vol. 38, Part I); revised this year (see current preprint).

Agglutinating Value of Coal (Committee D-5).—Study of laboratory test for obtaining information regarding the coking and caking

properties of coal. Experimental work by W. A. Selvig, B. B. Beattie, and J. B. Clelland described in paper on "Agglutinating-Value Test for Coal" (*Proc.*, Vol. 33, Part II). Proposed draft of a method which is an approximate measure of that material in coal which fuses and becomes plastic on heating published as information (Vol. 34, Part I). Sands from different sources being investigated to determine their suitability for use as an inert material in the proposed method of test (Vol. 36, Part I). Technique of test procedure being improved, also silicon carbide (carborundum) being investigated to determine its suitability for use as an inert material in the method (Vol. 37, Part I).

Pulverizing Characteristics of Coal (Committee D-5).—Investigation of laboratory methods to determine comparative pulverizing characteristics of different coals in connection with their commercial pulverization as powdered coal. Coal grindability tests have been made at 5 laboratories, using different methods on a series of 5 coals of wide range in grindability varying from a friable semibituminous to a hard anthracite. Studies of methods described in two papers presented before Coal Division of American Institute of Mining and Metallurgical Engineers, February, 1936, see also 1936 Report of Committee D-5. As a result of these studies two test methods have been developed for grindability of coal, namely, the ball-mill (D 408) and Hardgrove-machine (D 409) methods. Further investigative work resulted in extensive revision of the two methods (*Proc.*, Vol. 37, Part I). For references to papers on this subject see Report of Committee D-5, *Proc.*, Vol. 39; also special Report on Significance of Tests of Coal, *Proc.*, Vol. 37, Part II.

Friability of Coal (Committee D-5).—Investigation of methods for determining resistance of coal to breakage on handling. Methods of drop shatter test (D 440 – 37 T) and of tumbler test (D 441 – 37 T) for coal published (1939 Book of Standards, Part III). Studies being made at Fuel Research Laboratories, Canada Bureau of Mines, to determine the relationships between testing 2 by 3-in. lump coal by the drop shatter test method and the observed handling properties of the coals. Results of these studies will be published by the Canada Bureau of Mines. Of interest is a paper by E. S. Hertzog and J. R. Cudworth, "Friability of Alabama Coals," *Report of Investigations 3384*, U. S. Bureau of Mines (1938).

Dustiness of Coal and Coke (Committee D-5).—Investigative study of procedure for determination of dustiness of coal and coke based on method described in *Industrial and Engineering Chemistry*, by A. R. Powell and C. C. Russell, see *Proc.*, Vol. 36, Part I. Method of test for index of dustiness of coal and coke (D 547) issued as tentative (1939 Book of Standards, Part III).

Ignitability of Coal and Coke (Committee D-5).—Investigation of laboratory tests for determination of ignition temperatures of fuels. Agreement reached on proposed definition of the term "ignitability" (*Proc.*, Vol. 39). Current report states that comparative tests have been made using a method developed in the Coal Research Laboratory of the Carnegie Institute of Technology, see Preprint, 1940 Report of Committee D-5; also *Proc.*, Vol. 40.

Cubic Foot Weights of Crushed Bituminous Coal (Committee D-5).—Investigation of methods for determination of cubic foot weights of crushed bituminous coal. Test method to be developed that will give weights agreeing with those occurring in by-product coke ovens (*Proc.*, Vol. 38, Part I).

Plasticity and Swelling of Coal (Committee D-5).—Studies of methods of testing expanding properties of coals during coke manufacture; series of different coals to be distributed to cooperating laboratories for test. Investigation of plastic properties of coals as affecting their combustion characteristics also conducted (*Proc.*, Vol. 38, Part I; and Vol. 39). British Standards Institute crucible swelling test investigated. No immediate attempt to standardize coal expansion methods, see Preprint, 1940 Report of Committee D-5; also *Proc.*, Vol. 40.

Electrical Insulating Materials

Tests of Insulating Varnishes (Committee D-9).—Investigation and development of the following methods for varnish films: Hardness and oil resistance; acid and alkali resistance; and insulation resistance. Interlaboratory tests now under way to standardize a method of determining resistance of varnishes to acids, alkalies, and sea water, see Preprint, 1940 Report of Committee D-9; also *Proc.*, Vol. 40.

Tests of Saturant Varnishes (Committee D-9).—Studies of properties of saturant varnishes, such as impregnation, internal drying, bonding strength, and dielectric strength when the varnish is used as an impregnating medium in cotton fabrics. Effort being made to standardize baking ovens and drying cabinets, see Preprint, 1940 Report of Committee D-9; also *Proc.*, Vol. 40.

Tests of Molded Insulating Materials (Committee D-9).—Investigation of methods of measuring impact fatigue of molded plastics, and studies of dimensional tolerances suitable for impact test specimens, the effect of moisture content on impact and transverse strength; also, investigation of the effect of the type of mold on the physical strengths of plastic molded test specimens. Also tests for density and particle size of molding powders and plasticity and cure tests. Methods of testing molding powders used in manufacturing molded electrical insulators developed (D 392 – 38). Program for determining effect of conditioning upon the properties of molded materials resulted in development of a method of measuring shrinkage from mold dimensions (D 551 – 39 T) (1939 Book of Standards, Part III). For current program, see Preprint, 1940 Report of Committee D-9; also *Proc.*, Vol. 40.

Tests of Insulating Papers and Fabrics (Committee D-9).—Investigation and development of methods and apparatus for testing insulating papers, as follows: Tests for moisture in impregnated cable paper; acidity tests; oil penetration; air resistance of insulating paper and effect of humidity on dielectric strength of varnished cambric. Methods for thickness and folding endurance developed; also specifications and tests for varnished cloth tape and flexible tubing. Institute of Paper Chemistry to sponsor research on extracting the acid in paper (*Proc.*, Vol. 39).

Investigation of the pH method for determining the acidity of untreated papers being continued at National Bureau of Standards.

Tests of Insulating Sheets, Tubes and Rods (Committee D-9).—Involves the following studies of laminated sheet insulating materials: Method for determining compressibility as a function of time; methods of measuring the modulus of elasticity in compression; the effect of temperature variations on water absorption; effect of humidity on dielectric strength and on flexural strength; impact fatigue tests, arc resistance, hardness tests, punching quality and insulation resistance tests; methods of test for flammability and heat resistance; also tests for uniformity of product. On this latter, indentation hardness test using Rockwell tester developed. Specifications for laminated phenolic materials for radio use issued (D 467 – 40 T) (1940 Supplement).

Methods of conditioning sheet (D 229) rods (D 349) and tube materials (D 348) to insure reproducibility of mechanical tests adopted (1939 Book of Standards, Part III). Methods of conditioning the same materials for electrical tests being developed; comparative tests being made. For progress on other items, see Preprint, 1940 Report of Committee D-9; also *Proc.*, Vol. 40.

Tests of Liquid Insulation (Committee D-9).—Studies of the following tests of insulating oils: Neutralization value of both new and used oils; resistance of insulating oils to oxidation (sludge tests); tests for moisture content and for saponification value test to determine gas content of oil, the power factor of oil-treated papers, and the review of the entire dielectric strength test procedure. For summary of 4-yr. work on sludge tests, see paper by F. M. Clark and E. A. Snyder on "Testing for Sludge Formation in Mineral Transformer Oil" (*Proc.*, Vol. 36, Part II). Draft of potentiometric method for neutralization number published as information; test for saponification number (D 94 – 39 T) issued (1939 Book of Standards, Part III). See also papers by F. M. Clark on "Studies in the Oxidation of Mineral Transformer Oil" (Vol. 38, Part II) and "A Correlation of the Chemical and Electrical Changes Observed During the Oxidation of Mineral Insulating Oil" (issued as separate Preprint; also *Proc.*, Vol. 40). (See also Preprint, 1940 Report of Committee D-9.)

Tests of Insulating Compounds (Committee D-9).—Investigation of methods of test for solid filling and treating compounds used for electrical insulation, including: Coefficient of expansion; determination of insulation-resistance temperature characteristics; specimens and tests for dielectric strength; also viscosity tests of high melting asphaltic compounds. Procedures developed for measuring coefficient of expansion and for power factor and dielectric strength (D 176 – 40 T), see 1940 Supplement.

Power Factor and Dielectric Constant of Insulating Materials (Committee D-9).—Development and preparation of test methods for measuring dielectric constant and power factor of liquid insulation and of solid insulating materials. Work in progress on power factor of liquid insulation. Study on power factor of electrical insulating materials at frequencies up to 100 megacycles are continuing. For standard resistivity test (D 257 – 38), see 1939 Book of Standards, Part III. For current progress, see Preprint, 1940 Report of Committee D-9; also *Proc.*, Vol. 40.

Tests of Mica Products (Committee D-9).—Study of methods covering mica for capacitor manufacture and built-up pasted mica for general insulating purposes. Methods standardized for grading and classification of natural mica, testing pasted mica, and test for power factor and dielectric constant (D 351 – 38, D 352 – 39) D 351 – 39 T, (1939 Book of Standards, Part III). For current progress, see Preprint, 1940 Report of Committee D-9.

Tests for Properties of Ceramic Products (Porcelain, Glass, etc.) for Electrical Purposes (Committee D-9).—Comprehensive study of mechanical and electrical tests for evaluating the characteristics of glass for electrical insulating purposes. Methods of testing pin-type lime glass insulators (D 468) issued and also tests for glass spool insulators (D 550) (1939 Book of Standards, Part III). Cooperative tests to be made on electrical porcelain for flexural strength, tensile strength, and resistance to impact (Preprint, 1940 Report of Committee D-9).

Rubber Products

Life Test for Rubber Products (Committee D-11).—Accelerated aging tests of various types of rubber compounds in comparison with natural aging of the same samples. Previous methods of test for accelerated aging of vulcanized rubber separated in 1940 into procedures by oxygen-pressure method (D 572) and oven method (D 573). Method for air pressure heat test of vulcanized rubber (D 454 – 40) adopted, see 1940 Supplement.

Method of testing rubber compounds for resistance to light checking and cracking (D 518 – 38 T) issued (*Proc.*, Vol. 38, Part I). A cooperative test program conducted to determine the uniformity of aging in the various types of apparatus currently used in different laboratories completed; for conclusions see *Proc.*, Vol. 39, Part I. In August, 1940, methods of testing rubber compounds for resistance to accelerated light aging and of calibrating a light source used for accelerating the deterioration of rubber accepted for publication as information. For discussion of methods, see Preprint, 1940 Report of Committee D-11; also 1940 "A.S.T.M. Standards on Rubber"; and *Proc.*, Vol. 40.

Dynamic Fatigue Testing for Rubber Products (Committee D-11).—To study the general field indicated in title and particularly as applied to repeated extension, compression, bending and similar tests. Studying separation tests on plied rubber and fabric materials. Methods for flexing tests of rubber products (D 430 – 40) adopted. New methods of test to be prepared for the effect of compression hysteresis on vulcanized rubber (*Proc.*, Vol. 39).

Adhesion of Rubber to Metal (Committee D-11).—Study, development and standardization of methods for measuring the adhesive strength of rubber to metal with particular reference to such applications in the automotive industries. Methods of test for adhesion of vulcanized rubber to metal (D 429 – 39).

Results given of comparative study of adhesion tests of rubber to metal, in which the separating force is applied to the adhered surface in direct tension, and those in shear (*Proc.*, Vol. 38, Part I).

Tests of Rubber Cements and Rubber Latex (Committee D-11.)—Formulation of standard methods of test for the evaluation of rubber cements and rubber latex. Work on cements included tests for viscosity and determination of total solids content, (method issued, D 553 – 39 T); and on latex, methods will be investigated for color, total solids, dry rubber content, ammonia, and hydrogen ion concentration. Comparative tests completed in five laboratories on methods for determining viscosity of cement, see *Proc.*, Vol. 39.

Sponge Rubber (Committee D-11).—To advance standardization in the field of sponge rubber. First project to develop test procedures has resulted in publication as tentative of methods of testing sponge rubber products (D 552 – 39 T) (1939 Book of Standards, Part III).

Chemical Analysis of Rubber Products (Committee D-11).—Investigation of a number of methods of chemical analysis, including colorimetric methods, for determination of small amounts of manganese and copper; procedures for sulfur and carbon black; data developed on various chemical and spectroscopic methods. For discussion of cooperative work, see *Proc.*, Vol. 38, Part I, and Vols. 39 and 40. New modernized methods of chemical analysis of rubber products published as tentative this year (D 297 – 40 T) superseding former standard (1940 "A.S.T.M. Standards on Rubber Products"; also 1940 Supplement). Work done in cooperation with Federal Specifications Executive Committee (Preprint, 1940 Report of Committee D-11).

Tests (Physical, Chemical, Electrical) of Hard Rubber (Committee D-11).—Investigation of an extensive list of important properties of hard rubber in connection with work on standardizing testing procedures. Properties are classified in three groups: physical, chemical, and electrical (*Proc.*, Vol. 38, Part I). Standardized methods of testing hard rubber products issued (D 530 – 39) (1939 Book of Standards, Part III). Extensive cooperative testing program now in progress to make certain that the best methods have been selected and that results can be satisfactorily duplicated by using the methods, see Preprint, 1940 Report of Committee D-11; also *Proc.*, Vol. 40.

Soaps and Detergents

Sulfonated Detergents (Committee D-12).—As part of an extensive program involving studies and development of specifications and tests for soaps and detergents, cooperative laboratory work is in progress on method to evaluate sulfonated detergents by means of washing standard soiled cloth in a launderometer under varying conditions of temperature, solution concentration and alkalinity, and subsequently grading the wash towels by photometric readings. An analysis and summary of the results obtained is now in preparation.

Textile Materials

Methods of Testing Raw Cotton (Committee D-13).—Based upon fundamental research of cotton fiber quality such as that of the cotton fiber laboratories of the U. S. Bureau of Agricultural Economics, on studies of length, strength, fineness, maturity and color of raw cotton, work is being undertaken on specifications and suitable methods of measurement. General test methods for determining length, length distribution, fineness immaturity count, strength of cotton fibers, cross-sectioning, and neppiness developed; see 1940 "A.S.T.M. Standards on Textile Materials."

Tests of Rayon and Its Products (Committee D-13).—Studies of tension test for wet specimens, cloth fraying test, washability or launderability test; also methods to determine pulling at seams, slippage of fabrics, and oil and moisture contents of oiled rayons. Methods developed for identification of different types of rayon, for strength of rayon woven fabric when wet, for shrinkage in laundering, for slippage of woven rayon broad goods; test for spun rayon yarns and threads, and rayon staple (1940 "A.S.T.M. Standards on Textile Materials"). Symposium on Rayon held October, 1936; for papers, see 1937 "A.S.T.M. Standards on Textile Materials." Current work involves method for determining commercial weight of yarn, means of controlling shrinkage in the slippage test (D 434) and determining resiliency of staple fibers.

Tests of Wool and Its Products (Committee D-13).—Present considerations cover (1) the development of a method for the determination of moisture in wool tops for the purpose of specifying the limits of variation from the standard; (2) statistical analysis of measurements of wool tops with a view to defining the grades of this material in purely mathematical terms; (3) length specifications for wool top as used by the Wool Top Exchange; and (4) a method of tension testing of wool top, and woolen and worsted roving. Tests and tolerances for woolen and worsted yarns have been issued; also tests for estimating fineness of wool in loose form, methods for testing pile floor coverings, for estimating scoured content of grease wool, tests for wool felt, for fineness of wool tops, methods of testing certain wool and part wool fabrics, test for fiber length of wool, for yarns spun from wool mixed with other fibers, test for shrinkage of grease wool, 1940 "A.S.T.M. Standards on Textile Materials." For current progress, see Preprint, 1940 Report of Committee D-13; also, *Proc.*, Vol. 40.

Tests for Bleaching, Dyeing, and Finishing of Textiles (Committee D-13).—Methods of tests developed for fastness of dyed or printed cotton fabrics, and dyed or printed silk or rayon fabrics to laundering or domestic washing, for fastness of colored textile fabrics to light, for volumetric determination of small amounts of copper in textiles for apparent fluidity of dispersions of cellulose fibers in cuprammonium hydroxide, for resistance of fabrics to water, and for resistance of fabrics and yarns to moths, see 1940 "A.S.T.M. Standards on Textile Materials." Current agenda include the development of: (1) qualitative and quantitative methods of test for the determination of synthetic resin finishes on textiles; (2) a method for measuring the acidity and alkalinity of textile fabrics; and (3) a method for evaluating so-called "bacteria-static" finishes on textiles.

Tests for Bast Fibers and Their Products (Committee D-13).—Methods of testing and tolerances for single jute yarn developed; see 1940 "A.S.T.M. Standards on Textile Materials." Studies are being made of comparative results obtained by the pendulum and constant specimen-rate-of-load types of testing machines. Statistical methods are being applied to determine the precision of the test methods.

Felt (Committee D-13).—Part of a program involving wool and its products. Methods of testing wool felt developed; see 1940 "A.S.T.M. Standards on Textile Materials." Comprehensive program of work on felt is planned, including formulation of definitions and development of methods of test for permanent set, permanent recovery, dimensions of cut parts other than thickness, diameter of felt wicks, swell in cut parts and in flat sheet and roll felt, and materials soluble in water and in hydrochloric acid.

Textile Finishes (Committee D-13).—The development of physical test methods and instruments for the physical evaluation of the "hand" of fabrics. The types of finishes to be covered are: softened, crease-resistant, slip-proofed, shrink-proofed, and flame-proofed. Research work being done by an associate at the National Bureau of Standards. Work now being concentrated upon the evaluation of 3 factors: limpness, smoothness, and fullness. For current progress, see Preprint, 1940 Report of Committee D-13, also *Proc.*, Vol. 40.

Glass Fiber and Its Products (Committee D-13).—To develop test methods and tolerances for the new textile products being made of glass fiber. Methods of testing and tolerances for glass yarn (D 578 – 40 T), woven glass tapes (D 580 – 40 T), woven glass fabrics (D 579 – 40 T), and woven glass tubular sleeving and braids (D 581 – 40 T) issued as tentative this year (see Preprint, 1940 Report of Committee D-13; also 1940 Supplement). A comparative study is now being made of the results obtained in breaking tests of glass yarn by the pendulum and constant specimen-rate-of-load types of testing machines.

Soils

Tests for Soils for Engineering Purposes (Committee D-18).—Study and formulation of standard methods of procedure for the following tests of soils for engineering purposes: Physical characteristics, compressibility and elasticity, shearing properties, mechanical stability, load capacity of soil in place, bearing capacity of piles, and drainage properties.

Eight methods of test adopted (D 421 – 39 to D 427 – 39 incl.) see 1939 Book of Standards, Part II.

Following methods of test for stabilized (soil-cement) soils developed: moisture-density relations, wetting and drying, freezing and thawing (D 557, D 558 and D 559), see 1940 Supplement; also, Preprint, 1940 Report of Committee D-18; and reprinted in separate pamphlet form.

Of related interest are two papers, one by E. E. Bauer on "A Study of Deflocculating Agents Used in the Particle Size Determination of Soils" (*Proc.*, Vol. 38, Part II), and the other by C. A. Hogentogler, Sr., on "Application of Soil Mechanics" (ASTM Bulletin, No. 94, October, 1938). See also Symposium on Shear Testing of Soils, *Proc.*, Vol. 39; also separate reprint.

Industrial Waters

Methods of Analysis of Industrial Waters (Committee D-19).—Methods developed for determination of chloride, calcium, hydroxide, carbonate, bicarbonate, orthophosphate, and sulfate ions in waters for industrial uses. Program contemplates tests for determination of silica, iron, aluminum, manganese, and hardness. Of related interest are papers presented at recent annual meetings of the Society (*Proc.*, Vols. 37 to 40 incl.).

Six methods issued for determining various ions; also procedures for sampling and for reporting results of water analysis (see 1939 Book of Standards and 1940 Supplement).

Plastics

Tests of Plastics (Committee D-20).—Very active program on development of test methods applicable to the finished products (molding materials, sheets, tubes and rods, and molded or fabricated articles) in the field of plastics. Following properties being studied: strength, hardness, thermal, optical, and permanence. Tests developed for index of refraction (D 542), resistance to chemical reagents (D 543), flammability (D 568), measuring flow temperatures (D 569), and for water absorption (D 570) (see 1939 Book of Standards, Part III; 1940 Supplement; for current work, see Preprint, 1940 Report of Committee D-20; also *Proc.*, Vol. 40).

Miscellaneous Subjects

Study of Very Finely Sized Material (Committee E-1).—Development of methods of procedure for particle size determination of particulate substances, such as powdered coal, cement, pigments, by means of liquid elutriation and direct microscopic observation using filar micrometer. Test for particle size distribution, E 20 (1939 Book of Standards, Parts II and III) developed. 1935 report describes cooperative series of tests on particle size measurement by the microscopic count method; also a proposed method of measurement of average particle diameter of sub-sieve particulate substances by dark field methods (Vol. 35, Part I). 1941 Symposium on Sub-Sieve Particle Size Measurements scheduled for Washington, D. C., in March.

General Study of Methods of Determining Consistency and Plasticity (Committee E-1).—The committee is cooperating with various agencies in the development of suitable standards for rheological properties of materials. Method of test developed for softening point by ring and ball apparatus which, in addition to testing bituminous materials, is applicable to rosins and most resins, both natural and synthetic (see 1939 Book of Standards, Parts II and III). For summary of final results of studies comparing tapered and shouldered rings, see Preprint, 1940 Report of Committee D-17 on Naval Stores; also *Proc.*, Vol. 40.

Symposium on Consistency held in 1937, consisting of nine papers; available as separate reprint. Definitions of terms relating to rheological properties of matter published (Preprint, 1940 Report of Committee E-1; *Proc.*, Vol. 40).

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